Sandia National Laboratories/New Mexico

PROPOSALS FOR NO FURTHER ACTION ENVIRONMENTAL RESTORATION PROJECT SWMUs 98, 82, 60, 8IA, 81B, 81D, 81E, 81F, 9, AND 117

September 2000

Environmental
Restoration
Project

United States Department of Energy
Albuquerque Operations Office

EXECUTIVE SUMMARY

Sandia National Laboratories/New Mexico (SNL/NM) is proposing a risk-based no further action (NFA) decision for Solid Waste Management Units (SWMUs) 98, 82, 60, 81A, 81B, 81D, 81E, 81F, 9, and 117. These SWMUs are proposed for an NFA decision based upon baseline and confirmatory sampling data demonstrating that constituents of concern (COCs) that could have been released from the SWMUs into the environment pose an acceptable level of risk under current and projected future land use, as set forth by the Criterion 5, which states, "The SWMU/AOC [area of concern] has been characterized or remediated in accordance with current applicable state or federal regulations, and the available data indicate that contaminants pose an acceptable level of risk under current and projected land use" (NMED March 1998). This executive summary briefly describes each SWMU and the basis for the NFA proposal.

- SWMU 98 (Building 863 TCA [trichloroethane] and Photochemical Release in Operable Unit [OU] 1302) was constructed in 1950 and in 1951 became the motion picture production and film processing division for SNL/NM. The site was listed as a SWMU because of silver recovery processes and for releases of TCA from a film-cleaning machine. SWMU 98 was characterized through a series of four investigations: 1) a Comprehensive Environmental Assessment and Response Program (CEARP) (1987), 2) an Environmental Restoration (ER) Preliminary Investigation in 1993, 3) a RCRA Facility Investigation (RFI) in 1995, and 4) an Additional RFI Field Investigation in 1999. The four investigations included a background review, a cultural resources survey, a sensitive species survey, and sampling data collection. The building was decontaminated, decommissioned, and demolished in 1999. Based upon field investigation data and the human health and ecological risk screening assessments, NFA is recommended for the site because no COCs (metals, volatile organic compounds [VOCs], semivolatile organic compounds [SVOCs]) were present in concentrations considered hazardous to human health or site ecological receptors for an industrial land-use scenario.

- SWMU 82 (Old Aerial Cable Site in OU 1332) was constructed in 1968 to study problems in an experimental Fuel-Air Explosive weapon. Phillips Laboratories currently uses the site as a High Energy Research Test Facility. SWMU 82 was characterized through a series of four investigations: 1) a CEARP in 1997, 2) an ER Preliminary Investigation in 1992, 3) an ER RFI between 1995 and 1999, and 4) a Voluntary Corrective Action (VCA) conducted in 1999. The four investigations included visual inspections of the site, a background review, radiological surveys, unexploded ordnance (UXO)/high explosives (HE) surveys, a cultural resources survey, and sampling data collection. Based upon field investigation data and the human health and ecological risk screening assessments, NFA is recommended for the site because no COCs (metals, VOCs, SVOCs, HE, or radionuclides) were present in concentrations or activity levels considered hazardous to human health or site ecological receptors for a recreational land use scenario.

- SWMU 60 (Bunker Area in OU 1333) was a supply bunker and control bunker. The control bunker was destroyed during explosive testing in 1979. During the explosive test two mock weapons containing HE, depleted uranium, and beryllium were detonated, and the control bunker was destroyed. SWMU 60 was characterized through three investigations: 1) a CEARP in 1985, 2) an ER Preliminary Investigation from 1989 to 1994, and 3) a VCA conducted in 1999. The site investigations included a Phase I site investigation, a background review, a UXO/HE survey, a radiation survey, a cultural resource survey, and a sensitive species survey. The VCA was conducted in 1999 and included radiological surveys to characterize depleted uranium contamination present on remaining structures and debris, demolition and removal of this material, and confirmatory sampling. Based upon field investigation data and the human health and ecological risk screening assessments, NFA is recommended for the site because no COCs (metals, HE, radionuclides) were present in concentrations or activity levels considered hazardous to human health or site ecological receptors for a recreational land use scenario.

- SWMU 81A (Catcher Box/Sled Track in OU 1333) was constructed in 1970 and is an active subunit of SWMU 81 (New Aerial Cable Facility). The site was constructed to support impact testing on weapons and other test units that could be subject to detonation at SWMU 81. SWMU 81A was characterized through three investigations: 1) a CEARP conducted in the mid-1980s, 2) an ER Preliminary Investigation in 1993, and 3) baseline sampling in 1998. The three investigations included a Phase I investigation, a background review of the site, a UXO/HE survey, a radiological survey, a cultural resource survey, a sensitive-species survey, and sampling data collection. Based upon field investigation data and the human health and ecological risk screening assessments, NFA is recommended for the site because no COCs (metals, VOCs, SVOCs, radionuclides) were present in concentrations or activity levels considered hazardous to human health or site ecological receptors for a recreational land use scenario.

- SWMU 81B (Impact Pad in OU 1333) was constructed in 1970 and is an active subunit of SWMU 81 (New Aerial Cable Facility). The pad was designed to provide an "unyielding surface" for testing the impact of weapons and transportation containers that are designed to house nuclear materials. SWMU 81B was characterized through three investigations: 1) a CEARP conducted in the mid-1980s, 2) an ER Preliminary Investigation in 1993, and 3) baseline sampling in 1998. The three investigations included a Phase I investigation, a background review of the site, a UXO/HE survey, a radiological survey, a cultural resource survey, a sensitive-species survey, and sampling data collection. Based upon field investigation data and the human health and ecological risk screening assessments, NFA is recommended for the site because no COCs (metals, VOCs, HE, radionuclides) were present in concentrations or activity levels considered hazardous to human health or site ecological receptors for a recreational land use scenario.

- SWMU 81D (Northern Cable Area in OU 1333) was constructed in 1984-1985 and is an active subunit of SWMU 81 (New Aerial Cable Facility). The site was constructed to provide a dedicated area for antiarmor tests. SWMU 81D was characterized through three investigations: 1) a CEARP conducted in the mid-1980s, 2) an ER Preliminary Investigation in 1993, and 3) baseline sampling in 1998. The three investigations included a Phase I investigation, a background review of the site, a UXO/HE survey, a radiological survey, a cultural resource survey, a sensitive-species survey, and sampling data collection. Based upon field investigation data and the human health and ecological risk screening assessments, NFA is recommended for the site because no COCs (metals, VOCs, radionuclides) were present in concentrations or activity levels considered hazardous to human health or site ecological receptors for a recreational land use scenario.

- SWMU 81E (Gun Impact Area in OU 1333) is an inactive subunit of SWMU 81 (New Aerial Cable Facility). The site is the area impacted from the projectiles shot from portable guns in SWMUs 81A and 81B. SWMU 81E was characterized through three investigations: 1) a CEARP conducted in the mid-1980s, 2) an ER Preliminary Investigation in 1993, and 3) baseline sampling in 1998. The three investigations included a Phase I investigation, a background review of the site, a UXO/HE survey, a radiological survey, a cultural resource survey, a sensitive-species survey, and sampling data collection. Based upon field investigation data and the human health and ecological risk screening assessments, NFA is recommended for the site because no COCs (metals, radionuclides) were present in concentrations or activity levels considered hazardous to human health or site ecological receptors for a recreational land use scenario.

- SWMU 81F (Scrap Yard in OU 1333) is an active subunit of SWMU 81 (New Aerial Cable Facility). The site was constructed in 1970 and has been used for storage of test equipment associated with SWMU 81 subunits. SWMU 81E was characterized through three investigations: 1) a CEARP conducted in the mid-1980s, 2) an ER Preliminary Investigation in 1993, and 3) baseline sampling in 1998. The three investigations included a Phase I investigation, a background review of the site, a UXO/HE survey, a radiological survey, a cultural resource survey, a sensitive-species survey, and sampling data collection. Based upon field investigation data and the human health and ecological risk screening assessments, NFA is recommended for the site because no COCs (metals, VOCs, SVOCs, HE, radionuclides) were present in concentrations or activity levels considered hazardous to human health or site ecological receptors for a recreational land use scenario.

- SWMU 9 (Burial Site/Open Dump [Schoolhouse Mesa] in OU 1334) is an inactive debris disposal area. SWMU 9 was characterized through a series of four investigations: 1) a CEARP in the mid-1980s, 2) an ER Preliminary Investigation in 1992, 3) preliminary RFI sampling in 1991, and 4) a radiological voluntary corrective measure (VCM) to excavate and remove buried materials between 1996 and 1998 followed by confirmatory sampling in 1999. The four investigations included a background review, a UXO/HE survey, radiological surveys and VCM excavations, a cultural resource survey, a sensitive species survey, and soil sampling data collection. Based on the field investigation data and the human health and ecological risk screening assessments, NFA is recommended for the site because no COCs (metals, VOCs, SVOCs, HE, radionuclides) were present in concentrations or activity levels considered hazardous to human health or site ecological receptors for an industrial land use scenario.

- SWMU 117 (Trenches [Building 9939] in OU 1335) were disposal trenches that were dug to receive water runoff and reaction products resulting from water sprayed on residual solidified sodium metal in concrete test crucibles. Some solid waste items were also disposed of in one of the trenches. SWMU 117 was characterized through a series of three investigative stages: 1) a CEARP conducted in 1987, 2) ER Preliminary Investigations in 1994, 1995, 1997, and 1998, and 3) a VCA Remediation in 1999/2000. The three investigation stages included a background review, a UXO/HE survey, a radiological survey, a cultural resource survey, a sensitive-species survey, a geophysical survey, and sampling data collection. Based upon field investigation data and the human health and ecological risk screening assessments, NFA is recommended for the site because no COCs (metals, SVOCs, radionuclides) were present in concentrations or activity levels considered hazardous to human health or the environment for an industrial land use scenario.

REFERENCES

New Mexico Environment Department (NMED), March 1998. "RPMP Document requirement Guide," Hazardous and Radioactive Materials Bureau, RCRA Permits Management Program, New Mexico Environment Department, Santa Fe, New Mexico.

1.0 INTRODUCTION

Sandia National Laboratories/New Mexico (SNL/NM) is proposing No Further Action (NFA) recommendations for ten Environmental Restoration Solid Waste Management Units (SWMU). The following SWMUs are listed in the Hazardous and Solid Waste Amendments Module IV of the SNL/NM Resource Conservation and Recovery Act Hazardous Waste Management Facility Permit (NM5890110518) (EPA August 1993). Proposals for each SWMU are located in this document as follows:

Operable Unit 1302

- SWMU 98, Building 863 TCA and Photochemical Release

Operable Unit 1332

- SWMU 82, Old Aerial Cable Site

Operable Unit 1333

- SWMU 60, Bunker Area
- SWMU 81A, Catcher Box/Sled Track
- SWMU 81B, Impact Pad
- SWMU 81D, Northern Cable Area
- SWMU 81E, Gun Impact Area
- SWMU 81F, Scrap Yard

Operable Unit 1334

- SWMU 9, Burial Site/Open Dump (Schoolhouse Mesa)

Operable Unit 1335

- SWMU 117, Trenches (Building 9939)

These proposals each provide a site description, history, summary of investigatory activities, and the rationale for the NFA decision, as determined from assessments predicting acceptable levels of risk under current and projected future land use.

REFERENCES

U.S. Environmental Protection Agency (EPA), August 1993. "Module IV of RCRA Permit No. NM5890110518-1," EPA Region VI, issued to Sandia National Laboratories, Albuquerque, New Mexico.

CHAPTER 5.0
TABLE OF CONTENTS

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CHAPTER 5.0
LIST OF FIGURES

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CHAPTER 5.0
LIST OF TABLES

Table **Page**

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CHAPTER 5.0
LIST OF ANNEXES

Annex

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5.0 SOLID WASTE MANAGEMENT UNIT 81A: CATCHER BOX/SLED TRACK

5.1 Summary

Sandia National Laboratories/New Mexico (SNL/NM) is proposing a risk-based no further action (NFA) decision for Environmental Restoration (ER) Solid Waste Management Unit (SWMU) 81A, Catcher Box/Sled Track, Operable Unit (OU) 1333 on Kirtland Air Force Base (KAFB). SWMU 81A is an active subunit located on the eastern arm of the New Aerial Cable Facility (Figure 5.1-1). This NFA decision is based on environmental sampling documenting that historic operations at the site did not cause contamination that poses a threat to human health or the environment. Current operations at the site are conducted in accordance with applicable laws and regulations that are protective of the environment. The original sled track and catcher box at the New Aerial Cable Facility were constructed in 1970 in support of impact testing conducted in the southern cable area. Composed of hardened concrete (SNL/NM June 1993), the catcher box is approximately 12 feet high by 12 feet deep by 16 feet wide (Palmieri March 1995), and is located about 50 feet off the east end of the sled track. An earthen berm with concrete thrust shields is located approximately 50 feet west of the base of the sled track and protects the impact pad area (SWMU 81B) from rocket exhaust. The original sled track was removed in late 1992 and was replaced with a new sled track with similar specifications (Gaither July 1992). Construction associated with replacing the old sled track was completed in early 1993. The approximately 600-foot-long new sled track is supported by cement piers resting on bedrock on about 25-foot centers that are set 3 to 20 feet deep. The sled track runs approximately east-west up a hillside and is estimated to be on a 20-degree slope that rises to the east. Brush has been cleared within about 20 to 30 feet on either side of the sled track (SNL/NM June 1993).

This NFA addresses possible releases from the Catcher Box/Sled Track. Review and analysis of all relevant data for SWMU 81A indicate that concentrations of constituents of concern (COC) at this site are below applicable risk assessment action levels. Thus, SWMU 81A is proposed for an NFA decision based upon baseline sampling data demonstrating that COCs that may have been released from the SWMU into the environment pose an acceptable level of risk under current and projected future land uses as set forth by Criterion 5, which states, "The SWMU/AOC [area of concern] has been characterized or remediated in accordance with current applicable state or federal regulations, and the available data indicate that contaminants pose an acceptable level of risk under current and projected future land use" (NMED March 1998).

5.2 Description and Operational History

Section 5.2 describes SWMU 81A and discusses its operational history.

5.2.1 Site Description

SWMU 81A is a subunit of SWMU 81, identified as the New Aerial Cable Facility on the Resource Conservation and Recovery Act (RCRA) Hazardous and Solid Waste Amendments (HSWA) permit (Figure 5.2.1-1). SWMU 81A is located on U.S. Air Force (USAF) land withdrawn from the U.S. Forest Service (USFS) and permitted to the U.S. Department of Energy (DOE). The site is located on a western sloping hillside on the east side of the Sol se Mete

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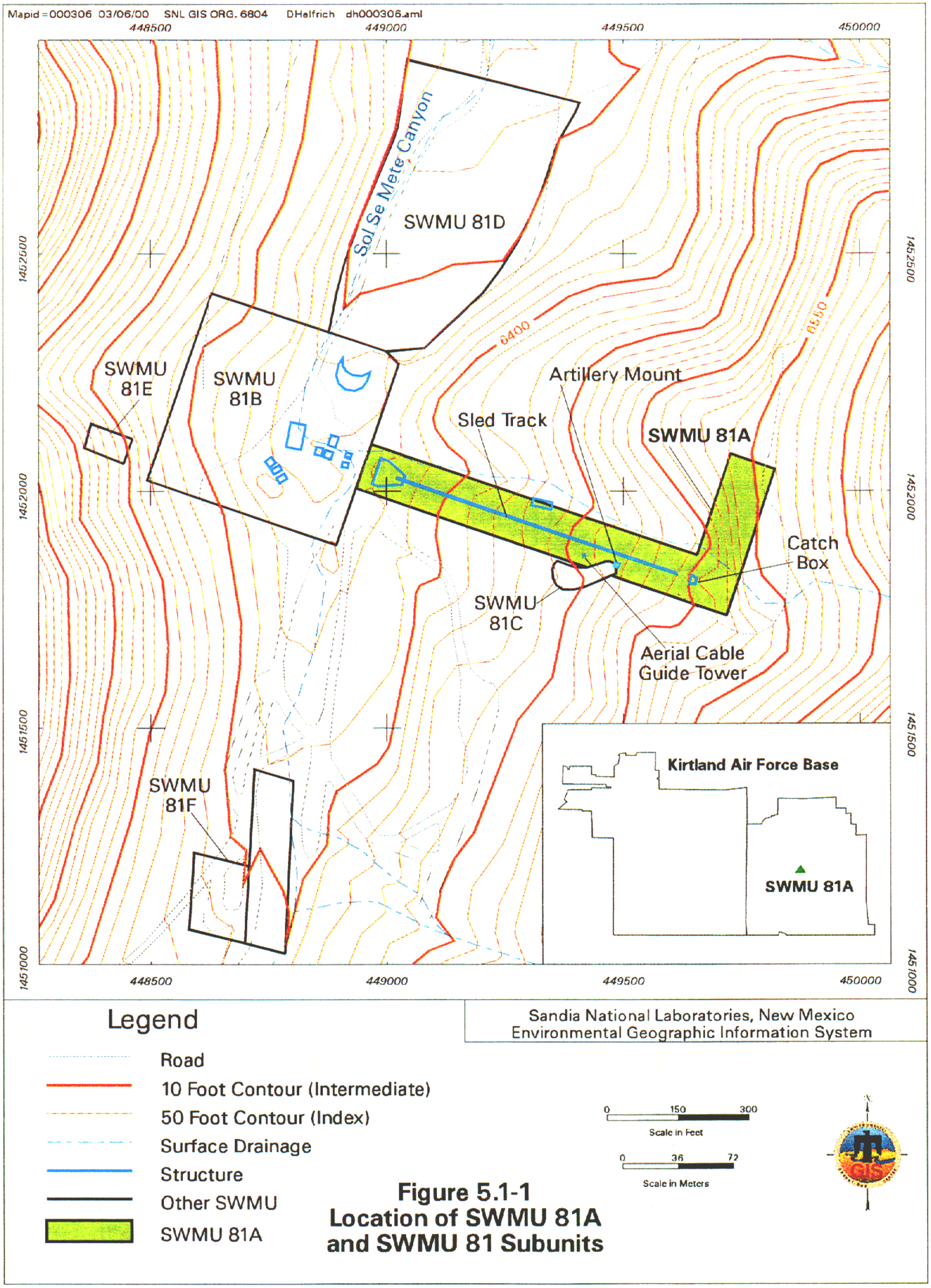
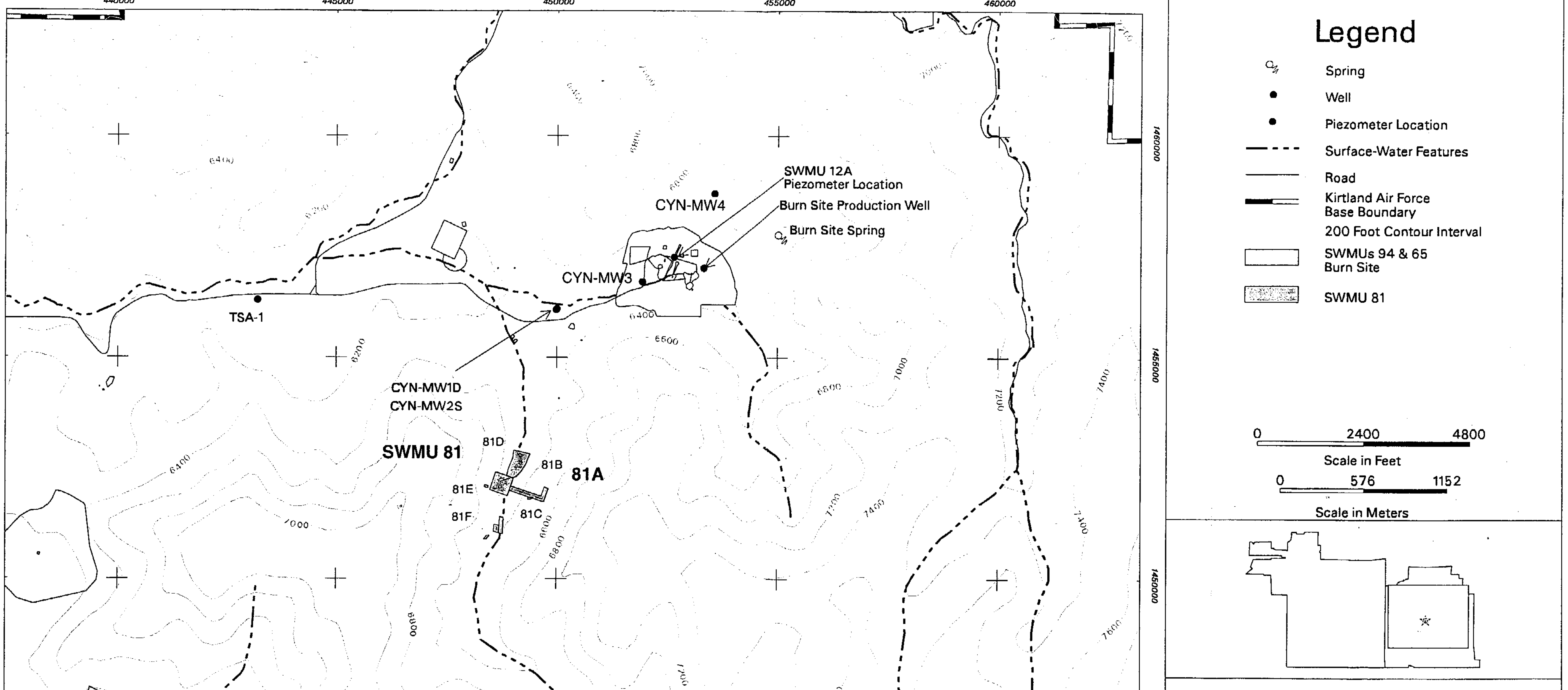


Figure 5.1-1
Location of SWMU 81A
and SWMU 81 Subunits



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Figure 5.2.1-1
Location of SWMU 81A within Operable Unit 1333

Transverse Mercator Projection, New Mexico State Plane Coordinate System, Central Zone, 1927 North American Horizontal Datum, 1929 North American Vertical Datum

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Canyon at an elevation of approximately 6,465 feet above sea level. The Sol se Mete Canyon drains to the north into the Lurance Canyon, which, in turn, drains to the west into the Arroyo del Coyote. Coyote Springs Road follows the drainage of the Lurance Canyon and is the main access to the service road into Sol se Mete Canyon.

SWMU 81A is an active subunit located in the eastern arm of the southern cable area at SWMU 81. The site comprises approximately 2.4 acres (SNL/NM April 1995). The original sled track and catcher box at the New Aerial Cable Site were constructed in 1970 in support of impact testing conducted in the southern cable area.

Recycled uncontaminated rail from the north end of the sled track in Technical Area 3 was used to construct the original sled track at SWMU 81 (Gaither et al. May 1993). Composed of hardened concrete (SNL/NM June 1993), the catcher box is approximately 12 feet high by 12 feet deep by 16 feet wide (Palmieri March 1995), and is located about 50 feet from the east end of the sled track. An earthen berm with concrete thrust shields is located approximately 50 feet west of the base of the sled track and protects the impact pad area (SWMU 81B) from rocket exhaust. A large green Y-shaped tower on the south side of the sled track is associated with other towers that hold the Kevlar aerial cable off the ground when the cable is lowered (Abitz January 1995). The original sled track was removed in late 1992 and was replaced with a new sled track with similar specifications (Gaither July 1992). Construction associated with replacing the old sled track was completed in early 1993. The approximately 600-foot-long new sled track is supported by cement piers resting on bedrock on about 25-foot centers that are set 3 to 20 feet deep. The sled track runs approximately east-west up a hillside and is estimated to be on a 20-degree slope that rises to the east (SNL/NM June 1993). Brush has been cleared within about 20 to 30 feet on either side of the sled track.

Testing activities at the New Aerial Cable Facility included gravitational accelerated (drop) tests and rocket sled pull-down tests. The rocket pull-down technique uses rocket sleds to accelerate towing cables attached to the test items. The test items are released from the overhead cable as the rockets are ignited and directed toward a target located on the canyon floor.

Specialized armament testing programs were conducted at SWMU 81 for the U.S. Navy target and scoring system. One fixed and two portable gun locations used in these programs are located within SWMU 81A. A 20-millimeter antiaircraft gun (Gun Site #1) is mounted on a concrete block next to the sled track. The two portable guns were located 20 feet north of the sled track (Gun Site #2) and 200 feet northeast of the catcher box (Gun Site #3).

Historical published information regarding the hydrogeology of Sol se Mete and Lurance Canyons was summarized in the "RCRA Facility Investigation (RFI) Work Plan for Operable Unit 1333, Canyons Test Area" (SNL/NM September 1995). Since that time, additional bedrock wells and alluvial piezometers have been installed in Lurance Canyon, and data collected from the new wells have supported the hydrologic model of semiconfined to confined groundwater conditions.

A groundwater monitoring well nest was installed in November and December 1997 approximately 4,350 feet north of SWMU 81A (Figure 5.2.1-1). The groundwater wells were installed in conformance with the documents of understanding between SNL/NM and the New Mexico Environment Department (NMED) Oversight Bureau (SNL/NM July 1997, SNL/NM September 1997). The monitoring well nest is comprised of a shallow underflow piezometer (CYN-MW2S) and a deep groundwater well (CYN-MW1D). The subsurface geology at the nest location is characterized by approximately 25 feet of alluvial sand, silt, and gravel, unconformably overlying the fractured Manzanita Gneiss. No water was encountered while drilling through the alluvium, and no water has been recorded at CYN-MW2S since its installation. Groundwater was first encountered in CYN-MW1D at a depth of 372 feet below ground surface (bgs), and the static level rose to 320 feet bgs. This indicates semiconfined to confined groundwater conditions similar to those encountered in the Burn Site Production Well.

Two additional monitoring wells, CYN-MW3 and CYN-MW4, were installed in June 1999 at the Burn Site. CYN-MW3 is approximately 5,400 feet northeast of SWMU 81A and CYN-MW4 is approximately 8,150 feet northeast of SWMU 81A (Figure 5.2.1-1). The downgradient monitoring well (CYN-MW3) is located within SWMU 65E, immediately west of where the Burn Site access road crosses the main arroyo of Lurance Canyon. The background monitoring well (CYN-MW4) is located approximately 1,350 feet northeast of the Burn Site within the secondary drainage northeast of the Burn Site. The subsurface geology at the monitoring well locations is characterized by approximately 20 to 35 feet of alluvial sand, silt, clay, and gravel, unconformably overlying a fractured phyllite schist and quartzite, referred to as the Coyote Metasediments. In CYN-MW4, approximately 65 feet of limestone was encountered above the schist. Groundwater was first encountered in CYN-MW3 at a depth of 124 feet bgs, and the static level rose to 104 feet bgs. Groundwater was first encountered in CYN-MW4 at a depth of 308 feet bgs, and the static level rose to 209 feet bgs. This indicates semiconfined to confined groundwater conditions similar to those encountered in the Burn Site production well and CYN-MW1D.

In summary, based upon data from the nearby Lurance Canyon wells, the groundwater beneath the floor of the Sol se Mete Canyon occurs under semiconfined to confined conditions in fractured metamorphic rock.

For a detailed discussion regarding the local setting at SWMU 81A, refer to the RFI Work Plan for OU 1333 (SNL/NM September 1995). This discussion includes details on the history of the other subunits of SWMU 81, as well as conceptual models and proposed sampling plans.

5.2.2 Operational History

SWMU 81, identified as the New Aerial Cable Site/Burial Site/Dump/Test Area in the HSWA Module, is located on USAF land withdrawn from the USFS and permitted to the DOE (SNL/NM July 1994). SWMU 81 consists of six subunits (SWMU 81A: New Aerial Cable Site: Catcher Box/Sled Track; SWMU 81B: New Aerial Cable Site: Impact Pad; SWMU 81C: New Aerial Cable Site: Former Burial Location; SWMU 81D: New Aerial Cable Site: Northern Cable Area; SWMU 81E: New Aerial Cable Site: Gun Impact Area; and SWMU 81F: New Aerial Cable Site: Scrap Yard) (Figure 5.1-1). Construction of the New Aerial Cable Site began in 1970 in response to the need to upgrade the aerial cable facilities that existed at the Old Aerial Cable Site (SWMU 82) (SNL/NM September 1995). The new aerial cable facilities support impact testing on weapons and other test units that could be subject to detonation (SNL/NM, September 1995). The initial construction activity at SWMU 81 was at the southern cable area and included the placement of the aerial cable anchors on the ridge crests east and west of Sol se Mete Canyon.

Testing activities at the Aerial Cable Facility include gravitational accelerated (drop) tests and rocket sled pull-down tests. The rocket pull-down technique uses rocket sleds to accelerate test items via towing cables. As the rockets are ignited, the test items are released from the overhead cable and directed toward a target. Multiple types of targets can be simulated for worst-case scenarios involving weapons systems, defensive systems, shipping containers, and transportation systems.

Visible debris associated with the operations of SWMU 81A from about 1971 to the present includes steel cables, spent rocket motors, and scrap metal. Small quantities of unburned solid rocket propellant are ejected from the rocket motors (Martz October 1985, Martz September 1985a) along with exhaust components.

5.3 Land Use

This section discusses the current and future land uses for SWMU 81A.

5.3.1 Current Land Use

SWMU 81A is located on withdrawn lands within the boundaries of KAFB (refer to Figure 5.3.1-1) within the active industrial New Aerial Cable Facility.

5.3.2 Future/Proposed Land Use

The projected land use for SWMU 81A is recreational (DOE et al. October 1995).

5.4 Investigatory Activities

SWMU 81A has been investigated in a series of three investigations. This section discusses the SWMU 81A investigatory activities.

5.4.1 Summary

SWMU 81A was originally investigated under the DOE Comprehensive Environmental Assessment and Response Program (CEARP) in the mid-1980s (Investigation #1) in conformance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). In 1993, preliminary investigations included background information reviews, interviews, field surveys, and scoping sampling (Investigation #2). In 1998, baseline sampling was conducted to determine if COCs exist at the site (Investigation #3).

5.4.2 Investigation #1—CEARP

5.4.2.1 Nonsampling Data Collection

SWMU 81 was evaluated during investigations conducted under the CEARP (DOE September 1987) and the RCRA Facility Assessment (RFA) (EPA April 1987). The RFA and CEARP Phase I reports state that debris from testing operations was deposited and partially buried in

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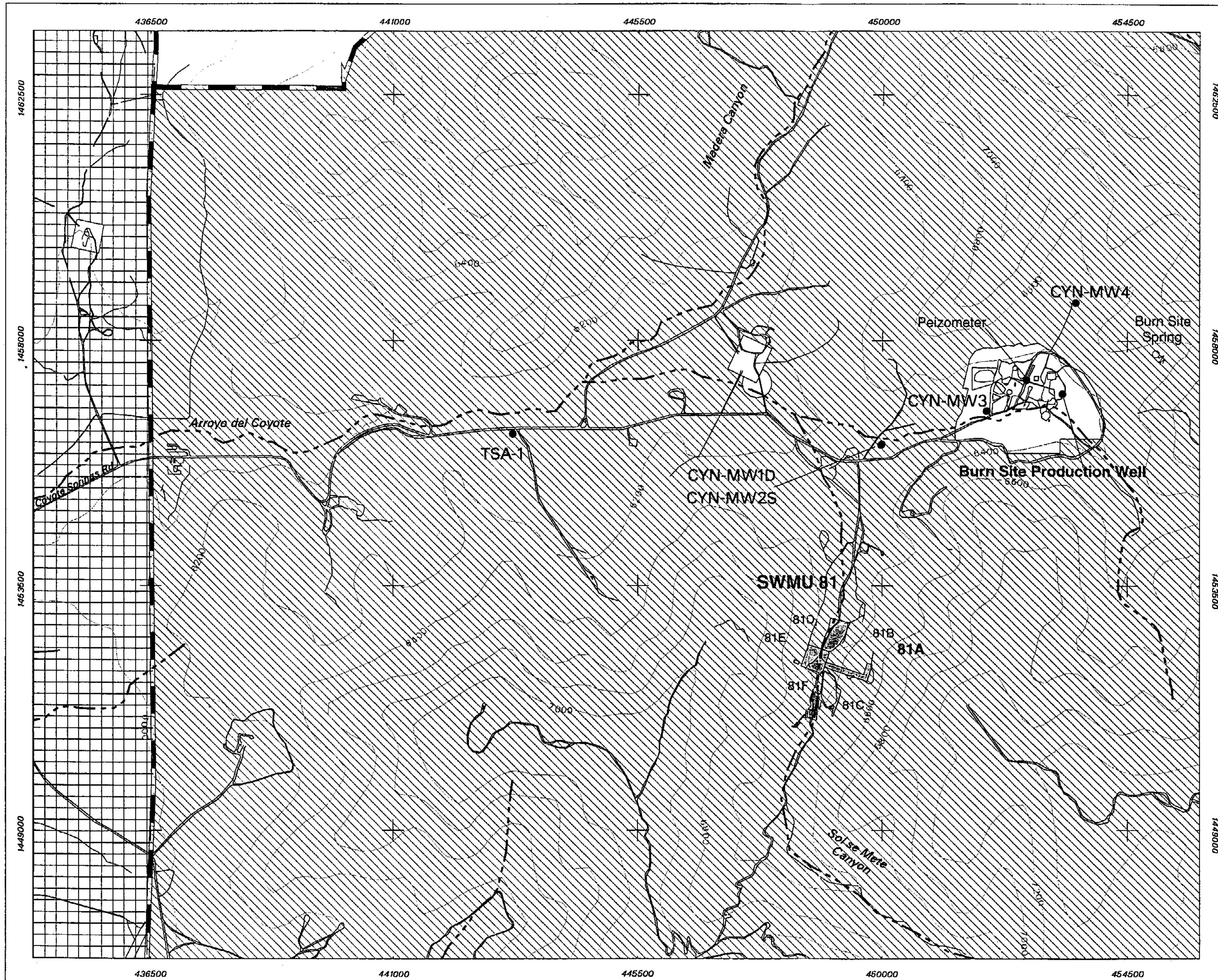

Legend

- Well
- Spring
- Piezometer Location
- Surface Water
- KAFB/USFS Boundary
- 200 Foot Contour Interval
- Road
- SWMU 81
- OU 1333 SWMU Site
- Future Proposed Recreational Land Use
- Industrial Land Use

0 2000 4000
Scale in Feet

0 480 960
Scale in Meters

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Figure 5.3.1-1
SWMU 81A, OU1333 SWMU Sites, and Associated Land Uses within KAFB Boundary & Vicinity

Transverse Mercator Projection, New Mexico State Plane Coordinate System, Central Zone, 1927 North American Horizontal Datum, 1929 North American Vertical Datum

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the arroyo on the south side of the sled track (SWMU 81C). Materials included old rockets, sleds, cables, scrap metal, and wood. Additionally, the Phase I report noted that area around the test facility may be contaminated with lead, beryllium, depleted uranium, and rocket propellants from test operations.

5.4.2.2 Sampling Data Collection

No sampling activities were conducted at SWMU 81A as part of the CEARP or RFA.

5.4.2.3 Data Gaps

The calculated Hazard Ranking System (HRS) and Modified HRS air and surface water migration scores were zero (no surface-water use within 3 miles). The groundwater HRS migration score was 6.1, far below the 28.5 required for inclusion on the National Priorities List.

5.4.2.4 Results and Conclusions

The CERCLA finding under the CEARP was positive for RCRA-regulated hazardous waste.

5.4.3 Investigation #2—SNL/NM ER Preliminary Investigations

5.4.3.1 SNL/NM ER Nonsampling Data Collection

This section describes the nonsampling data collected at SWMU 81A.

5.4.3.1.1 Background Review

A background review was conducted in order to gain available and relevant information regarding SWMU 81A. Background information sources included interviews with SNL/NM staff and contractors familiar with the site's operational history and reviews of existing historical site records and reports. The study was documented completely and has provided traceable references that sustain the integrity of the NFA proposal. Table 5.4.3-1 lists the information sources that were used to assist in evaluating SWMU 81A.

5.4.3.1.2 Unexploded Ordnance/High Explosives Survey

In December 1993, KAFB Explosive Ordnance Disposal personnel conducted a visual survey for the presence of unexploded ordnance on the ground surface at SWMU 81. The live ordnance found and removed in June 1994 included two experimental flares near the sled track. Ordnance debris at the site included several hundred spent rocket motors and rocket parts that have since been removed from the site.

Table 5.4.3-1
Summary of Background Information Review for SWMU 81A

Information Source	Reference
Technical test reports and project log books	Bickel September 1980
Site inspections (field notes, aerial photograph review, site photographs, radiological, UXO/HE, biological, and cultural resource surveys)	SNL/NM April 1985 SNL/NM August 1994 Sullivan August 1994 DOE March 1996
Employee interviews: three employee interviews with two facility personnel (current and retired)	Martz September 1985b Martz November 1985 Palmieri May 1992

DOE = U.S. Department of Energy.
HE = High explosive(s).
SNL/NM = Sandia National Laboratories/New Mexico.
SWMU = Solid Waste Management Unit.
UXO = Unexploded ordnance.

5.4.3.1.3 Radiological Survey(s)

SNL/NM Radiation Protection Operations (RPO) has historically performed surveys after impact tests were conducted at SWMU 81 and has found no radioactive material. In April and May 1993, SNL/NM RPO performed a radiation survey of the service road that passes through SWMU 81. The survey consisted of driving the road, performing periodic contamination surveys of the vehicles, and collecting air samples from behind the vehicle. No contamination was detected in the dust kicked up by the vehicle (Oldewage May 1993).

SNL/NM RPO conducted a surface gamma radiation survey in January 1994 that included a survey of debris and shrapnel at the site. No anomalies were found in the impact area and no contamination was detected on the debris. One metal fragment, high in natural thorium series, was found buried 2 to 3 inches deep. The metal was of unknown origin. The metal fragment was removed for analysis, effectively decontaminating the area.

In March 1994, RUST Geotech Inc. conducted a surface gamma radiation survey of SWMU 81. The background gamma exposure rates ranged from 9 to 13 microroentgens per hour. Four areas of gamma activity greater than 30 percent above natural background levels were identified. All four anomalies were attributed to outcrops of bedrock. The outcrops exhibited no visible evidence of depleted uranium (DU). The elevated readings are consistent with outcrops of similar appearance found at other SWMUs and appear to be a natural characteristic of the rock and soil in the area (RUST Geotech Inc. December 1994).

Based upon the historical use of DU at SWMU 81, the site had been classified as a radioactive material management area (RMMA). However, based upon the results of the radiological surveys described above, the site was removed from RMMA status in April 1998 (Vigil April 1998).

5.4.3.1.4 *Cultural Resources Survey*

A cultural resources survey of SWMU 81 was conducted. No cultural resources were found during this survey (DOE March 1996).

5.4.3.1.5 *Sensitive-Species Survey*

A sensitive-species survey and biological field investigation of SWMU 81 and surrounding support facilities was conducted in September and October 1991. No threatened, endangered, or sensitive species of plants were found at SWMU 81 (Sullivan August 1994).

5.4.3.2 *Sampling Data Collection*

In July 1995, SWMU 81A was investigated as part of a sitewide scoping sampling program. The purpose of this effort was to obtain preliminary analytical data to support the ER Project site ranking and prioritization. Four sampling locations were selected within the boundaries of SWMU 81A. A surface (0 to 6 inches) and a subsurface (6 inches to 1.5 feet) sample were collected at two of the locations, one surface sample was collected at the other two locations. The SNL/NM ER Chemistry Laboratory analyzed the four environmental samples for RCRA metals (plus beryllium) using modified U.S. Environmental Protection Agency (EPA) Method 6010 (EPA November 1986) and high explosives (HE) using high performance liquid chromatography.

5.4.3.3 *Data Gaps*

Information gathered from process knowledge, reviewing historical site files, and personal interviews aided in identifying the most likely COCs at SWMU 81A and in selecting the types of analyses to be performed on soil samples. However, the preliminary scoping sampling data are not adequate to support a risk screening assessment.

5.4.3.4 *Results and Conclusions*

Only barium, chromium, and lead were detected in the soil samples. None of the six barium concentrations were above the background limit of 246 milligrams (mg)/kilogram (kg). Chromium was detected in three of the six samples, all concentrations were estimated, and none were above the background concentration limit of 18.8 mg/kg. Lead concentrations were all estimated and ranged between 11 and 22 mg/kg, with one of the six exceeding the background concentration limit of 18.9 mg/kg. Arsenic, cadmium, mercury, selenium, and silver were not detected; however, the method detection limits (MDL) ranged from 0.2 to 50 mg/kg (for mercury and for arsenic and selenium, respectively). No HE compounds were detected in any of the soil samples at MDLs ranging from 150 to 750 micrograms (μg)/kg. No duplicate samples were analyzed.

5.4.4 Investigation #3—Baseline Sampling

5.4.4.1 Nonsampling Data Collection

There were no nonsampling data collection activities associated with Investigation #3 of SWMU 81A.

5.4.4.2 Sample Data Collection

SNL/NM conducted baseline soil sampling at SWMU 81A in September 1998 to determine whether potential COCs were present at levels exceeding background limits at the site and/or at levels sufficient to pose a risk to human health or the environment. All sampling activities were performed in accordance with the rationale and procedures described in the RFI work plan for OU 1333 (SNL/NM September 1995) and the SNL/NM response to the Request for Supplemental Information (RSI) on the OU 1333 Work Plan (SNL/NM October 1997). Based on the RSI volatile organic compounds, gross alpha, gross beta, and gamma spectroscopy were added to the analyte list and the number of sample locations was increased from 8 to 16 for the Catcher Box/Sled Track and from one to four at Gun Firing Sites 1, 2, and 3. SNL/NM chain-of-custody and sample documentation procedures were followed for all samples that were collected. Figure 5.4.4-1 shows the baseline sample location associated with SWMU 81A.

In September 1998, surface (0 to 1.0 foot bgs) soil samples were collected at SWMU 81A from 28 locations. A total of 16 sample location were randomly selected along both sides of the Sled Track and around the Catcher Box. A total of four sampling locations were selected around each of the Gun Firing Sites 1, 2, and 3. Quality assurance (QA)/quality control (QC) samples collected included one duplicate sample and one equipment blank.

All soil samples collected in September 1998 were analyzed off site for volatile organic compounds (VOCs), metals, HE, and gross alpha and gross beta activity. In addition, the soil samples collected from Gun Firing Sites 1, 2, and 3 were also analyzed for semivolatile organic compounds (SVOCs). General Engineering Laboratories of Charleston, South Carolina, analyzed the samples for VOCs using EPA Method 8260, SVOCs using EPA Method 8270, RCRA metals plus beryllium using EPA Method 6010/7000, HE using EPA Method 8330, and gross alpha and gross beta using EPA Method 900.0 (EPA November 1986). In addition, SNL/NM Department 7713 Radiation Protection Sample Diagnostics (RPSD) Laboratory also used gamma spectroscopy to analyze the samples for radionuclides.

5.4.4.2.1 Data Gaps

Analytical data from baseline sampling are sufficient to characterize the nature and extent of historical releases of COCs at the site. There are no further data gaps regarding characterization of SWMU 81A.

5.4.4.2.2 Results and Conclusions

In September 1998, soil samples were collected from 28 locations at SWMU 81A in conformance with the RFI Work Plan (SNL/NM September 1995), as reviewed by NMED, and

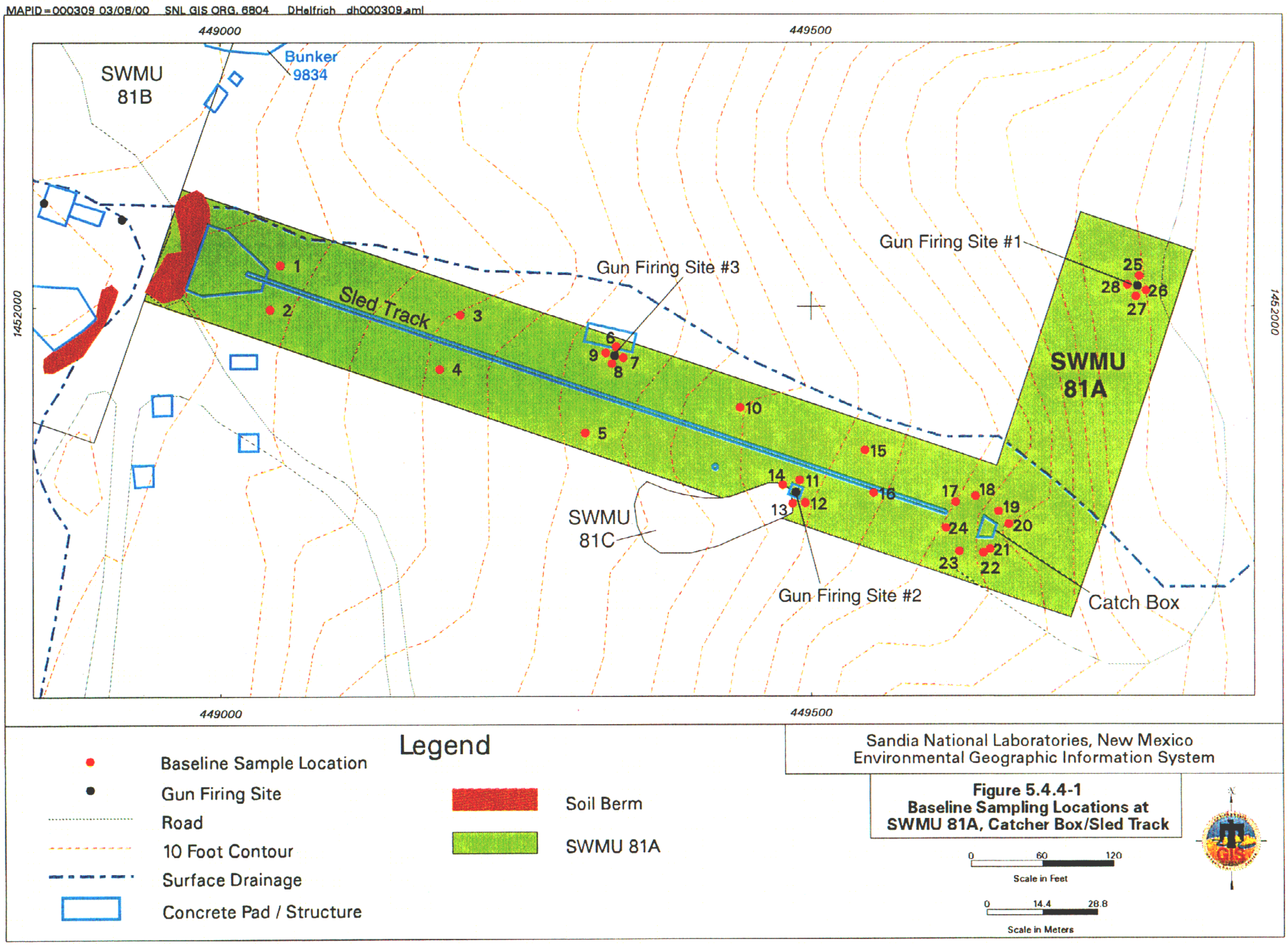

Figure 5.4.4-1
Baseline Sampling Locations at SWMU 81A, Catcher Box/Sled Track

the SNL/NM response to the Request for Supplemental Information on the OU 1333 Work Plan (SNL/NM October 1997).

Tables 5.4.4-1, 5.4.4-2, 5.4.4-4, 5.4.4-7, and 5.4.4-8 summarize the metals, VOC, SVOC, and radionuclide (i.e., gamma spectroscopy, gross alpha, and gross beta) analytical results for all of the baseline soil samples collected at SWMU 81A. Annex 5-A contains complete results for the gamma spectroscopy analyses. Tables 5.4.4-3, 5.4.4-5, and 5.4.4-6 summarize the analytical method detection limits for the target analyte list for VOCs, SVOCs, and HE compounds, respectively.

Sample numbers are coded to identify specific information regarding the samples. For example, for CY81A-GR-001-SS, CY81A designates a sample collected from SWMU 81A in the Canyons Test Area of SNL/NM. GR indicates that a grab sample was collected from Location 001, and SS designates a surface soil sample. The remainder of this section describes the results of baseline sampling at SWMU 81A.

<u>Metals</u>

Table 5.4.4-1 summarizes the metals analysis results for the 28 baseline soil samples and one duplicate sample collected from SWMU 81A.

Beryllium, cadmium, chromium, and lead were detected above the background concentration limits in less than 20 percent of the samples collected at SWMU 81A. Beryllium was detected above the 0.75 mg/kg background concentration limit in four samples (CY81A-GR-012-SS, CY81A-GR-025-SS, CY81A-GR-026-SS, and CY81A-GR-027-SS), ranging in concentration from 0.88 mg/kg to 1.10 mg/kg. Cadmium was detected above the 0.64 mg/kg background concentration limit in three samples (CY81A-GR-019-SS, CY81A-GR-024-SS, and CY81A-GR-024-DU), ranging in concentration from 0.68 mg/kg to 0.76 mg/kg. Chromium was detected above the 18.8 mg/kg background concentration limit in two samples (CY81A-GR-023-SS and CY81A-GR-026-SS); the concentrations were 19.6 mg/kg and 20.6 mg/kg. Lead was detected above the 18.9 mg/kg background concentration limit in five samples (CY81A-GR-012-SS, CY81A-GR-013-SS, CY81A-GR-014-SS, CY-81A-GR-023-SS, and CY81A-GR-024-SS), ranging in concentration from 19.7 mg/kg to 35.5 mg/kg. All metal concentrations were less than two times the background concentration limits.

<u>VOCs</u>

Because there are no background concentrations for VOCs in soil, any detectable VOCs in the samples collected at SWMU 81A may be considered an indication of contamination. Very low concentrations of three VOCs (bromodichloromethane, chloroform, and xylene) were detected in less than 25 percent of the samples at SWMU 81A. The following briefly describes the VOC analytical results for SWMU 81A.

Table 5.4.4-2 summarizes the off-site VOC analysis for the 28 soil samples and 1 duplicate sample collected. Three VOCs were detected, bromodichloromethane, chloroform, and xylene, in less than 25 percent of the samples at SWMU 81A. Two of the three VOCs detected at SWMU 81A were reported with some values at concentrations less than the practical quantitation limit and were, thus, qualified J (estimated values) by the laboratory.

Table 5.4.4-1
Summary of SWMU 81A Baseline Soil Sampling Metals Analytical Results
September 1998
(Off-Site Laboratory)

Sample Attributes			Metals (EPA Method 6010)[a] (mg/kg)								
Record Number[b]	ER Sample ID (Figure 5.4.4-1)	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
600781	CY81A-GR-001-SS	0.0–1.0	4.41	105	0.324 J (0.491)	ND (0.019)	9.49	11	0.0155 J (0.0331)	0.66	0.186 J (0.491)
600781	CY81A-GR-002-SS	0.0–1.0	5.36	157	0.451 J (0.481)	ND (0.019)	14.8	18.2	ND (0.00225)	0.613	0.278 J (0.481)
600781	CY81A-GR-003-SS	0.0–1.0	4.17	148	0.54	0.0764 J (0.502)	12.4	13.1	0.027 J	0.842	0.0887 J (0.502)
600781	CY81A-GR-004-SS	0.0–1.0	4.72	164	0.604	ND (0.019)	13.1	14.2	0.00574 J (0.0343)	0.596	0.243 J (0.482)
600781	CY81A-GR-005-SS	0.0–1.0	5.17	213	0.556	ND (0.019)	13.2	15.3	ND (0.00225)	0.725	0.186 J (0.482)
600781	CY81A-GR-006-SS	0.0–1.0	3.59	132	0.499	ND (0.019)	10.2	12.1	0.0119 J (0.0335)	0.491	0.231 J (0.481)
600781	CY81A-GR-007-SS	0.0–1.0	3.69	152	0.582	ND (0.019)	12.5	12.2	ND (0.00225)	0.721	0.248 J (0.476)
600781	CY81A-GR-008-SS	0.0–1.0	3.52	150	0.528	ND (0.019)	12.6	13.9	ND (0.00225)	ND (0.135)	0.225 J (0.468)
600781	CY81A-GR-009-SS	0.0–1.0	3.98	170	0.623	ND (0.019)	12.6	11.1	ND (0.00225)	0.419 J (0.476)	0.21 J (0.476)
600781	CY81A-GR-010-SS	0.0–1.0	3.9	162	0.568	ND (0.019)	13.1	13.7	ND (0.00225)	0.341 J (0.463)	0.177 J (0.463)
600781	CY81A-GR-011-SS	0.0–1.0	3.5	152	0.443 J (0.5)	0.142 J (0.5)	9.98	13.2	ND (0.00225)	0.36 J (0.5)	0.275 J (0.5)
600781	CY81A-GR-012-SS	0.0–1.0	6.73	234	**0.879**	ND (0.019)	13.3	**35.5**	0.0174 J (0.0344)	0.746	0.299 J (0.501)
600781	CY81A-GR-013-SS	0.0–1.0	4.91	132	0.523	ND (0.019)	11.7	**31.9**	ND (0.00225)	0.344 J (0.459)	0.278 J (0.459)
600781	CY81A-GR-014-SS	0.0–1.0	5.12	146	0.541	0.27 J (0.496)	13.3	**34.2**	ND (0.00225)	0.347 J (0.496)	0.304 J (0.496)
600781	CY81A-GR-015-SS	0.0–1.0	3.86	162	0.588	ND (0.019)	15	10.2	ND (0.00225)	0.904	0.292 J (0.506)
600781	CY81A-GR-016-SS	0.0–1.0	3.44	165	0.562	ND (0.019)	12.6	12.8	ND (0.00225)	0.303 J (0.482)	0.299 J (0.482)
600781	CY81A-GR-017-SS	0.0–1.0	3.87	154	0.639	0.59	12.1	17.3	0.00894 J (0.0323)	0.631	0.227 J (0.495)
600782	CY81A-GR-018-SS	0.0–1.0	5.4	152	0.67	0.633	14.7	17.8	0.0191 J (0.0328)	0.543	0.179 J (0.505)
600782	CY81A-GR-019-SS	0.0–1.0	4.9	166	0.685	**0.72**	15.1	15.8	0.0165 J (0.0354)	0.568	0.203 J (0.535)
600782	CY81A-GR-020-SS	0.0–1.0	4.13	165	0.696	ND (0.019)	14.6	10.3	0.00575 J (0.0355)	0.54	0.214 J (0.533)
600782	CY81A-GR-021-SS	0.0–1.0	4.84	180	0.738	0.24 J (0.507)	15.7	17.7	0.0245 J (0.0319)	0.746	0.224 J (0.507)
600782	CY81A-GR-022-SS	0.0–1.0	4.07	188	0.696	0.177 J (0.517)	15	17.4	0.017 J (0.0351)	0.736	0.219 J (0.517)
600782	CY81A-GR-023-SS	0.0–1.0	4.53	164	0.651	0.439 J (0.495)	**19.6**	**27.8**	0.0137 J (0.0336)	0.941	0.25 J (0.495)
600782	CY81A-GR-024-DU	0.0–1.0	4.21	156	0.669	**0.683**	13	**19.7**	0.0145 J (0.0345)	0.947	0.181 J (0.501)
600782	CY81A-GR-024-SS	0.0–1.0	4.26	153	0.665	**0.756**	13.5	17.9	0.0135 J (0.0319)	0.826	0.158 J (0.468)
Background Soil Concentrations—Canyons Area[c]			9.8	246	0.75	0.64	18.8	18.9	0.055	2.7	<0.50

Refer to footnotes at end of table.

Table 5.4.4-1 (Concluded)
Summary of SWMU 81A Baseline Soil Sampling Metals Analytical Results
September 1998
(Off-Site Laboratory)

Sample Attributes			Metals (EPA Method 6010[a]) (mg/kg)								
Record Number[b]	ER Sample ID (Figure 5.4.4-1)	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
600782	CY81A-GR-025-SS	0.0–1.0	5.67	160	**1.07**	ND (0.019)	18.3	11	0.0197 J (0.0325)	0.902	0.196 J (0.495)
600782	CY81A-GR-026-SS	0.0–1.0	6.19	167	**1.10**	ND (0.019)	**20.6**	10.5	0.0337	0.911	0.207 J (0.482)
600782	CY81A-GR-027-SS	0.0–1.0	5.41	148	**0.908**	ND (0.019)	17.5	10.7	0.00604 J (0.033)	0.758	0.165 J (0.5)
600782	CY81A-GR-028-SS	0.0–1.0	3.98	97	0.627	ND (0.019)	13	8.09	0.0112 J (0.0324)	0.766	0.144 J (0.472)
Background Soil Concentrations—Canyons Area[c]			9.8	246	0.75	0.64	18.8	18.9	0.055	2.7	<0.50
Quality Assurance/Quality Control Samples (all in µg/L)											
600781	CY81A-GR-001-EB	NA	R	0.00129 J (0.005)	ND (0.00026)	ND (0.00044)	0.00071 J (0.005)	ND (0.00159)	ND (0.00004)	ND (0.00271)	0.00265 J (0.005)

Note: Values in **bold** represent values exceeding background soil concentrations.

[a]EPA November 1986.

[b]Analysis request/chain-of-custody record.

[c]From Garcia November 1998.

CY = Canyon.
DU = Duplicate.
EB = Equipment blank.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
GR = Grab sample.
ID = Identification.
J ( ) = The reported value is greater than or equal to the MDL but is less than the practical quantitation limit, shown in parentheses.
µg/L = Microgram(s) per liter.
MDL = Method detection limit.
mg/kg = Milligram(s) per kilogram.
NA = Not applicable.
ND ( ) = Not detected above the method detection limit, shown in parentheses.
R = Rejected.
SS = Surface soil sample.
SWMU = Solid Waste Management Unit.

Table 5.4.4-2
Summary of SWMU 81A Baseline Soil Sampling VOC Analytical Results
September 1998
(Off-Site Laboratory)

Sample Attributes			VOCs (EPA Method 8260A)[a] (µg/kg)			
Record Number[b]	ER Sample ID (Figure 5.4.4-1)	Sample Depth (ft)	Bromodichloro methane	Chloroform	Methylene chloride	Xylene
600781	CY81A-GR-001-SS	0.0–1.0	ND (0.24)	ND (0.24)	ND (0.25)	ND (0.62)
600781	CY81A-GR-002-SS	0.0–1.0	ND (0.24)	ND (0.24)	ND (0.25)	ND (0.62)
600781	CY81A-GR-003-SS	0.0–1.0	ND (0.24)	ND (0.24)	ND (0.25)	ND (0.62)
600781	CY81A-GR-004-SS	0.0–1.0	ND (0.24)	ND (0.24)	ND (0.25)	ND (0.62)
600781	CY81A-GR-005-SS	0.0–1.0	ND (0.24)	ND (0.24)	ND (0.25)	ND (0.62)
600781	CY81A-GR-006-SS	0.0–1.0	ND (0.24)	ND (0.24)	ND (0.25)	ND (0.62)
600781	CY81A-GR-007-SS	0.0–1.0	ND (0.24)	ND (0.24)	ND (0.25)	ND (0.62)
600781	CY81A-GR-008-SS	0.0–1.0	ND (0.24)	ND (0.24)	ND (0.25)	ND (0.62)
600781	CY81A-GR-009-SS	0.0–1.0	ND (0.24)	ND (0.24)	ND (0.25)	**1 J (1.99)**
600781	CY81A-GR-010-SS	0.0–1.0	ND (0.24)	ND (0.24)	ND (0.25)	ND (0.62)
600781	CY81A-GR-011-SS	0.0–1.0	ND (0.24)	ND (0.24)	ND (0.25)	ND (0.62)
600781	CY81A-GR-012-SS	0.0–1.0	ND (0.24)	ND (0.24)	ND (0.25)	ND (0.62)
600781	CY81A-GR-013-SS	0.0–1.0	**1.3**	**5.1**	ND (0.25)	**0.92 J (1.98)**
600781	CY81A-GR-014-SS	0.0–1.0	ND (0.24)	**3.9**	ND (0.25)	ND (0.62)
600781	CY81A-GR-015-SS	0.0–1.0	**0.96 J (1.05)**	**3.7**	ND (0.25)	ND (0.62)
600781	CY81A-GR-016-SS	0.0–1.0	ND (0.24)	**3.7**	ND (0.25)	ND (0.62)
600781	CY81A-GR-017-SS	0.0–1.0	ND (0.24)	**2.5**	ND (0.25)	ND (0.62)
600782	CY81A-GR-018-SS	0.0–1.0	ND (0.24)	**2.6**	ND (0.25)	ND (0.62)
600782	CY81A-GR-019-SS	0.0–1.0	ND (0.24)	**4**	ND (0.25)	ND (0.62)
600782	CY81A-GR-020-SS	0.0–1.0	ND (0.24)	ND (0.24)	ND (0.25)	ND (0.62)
600782	CY81A-GR-021-SS	0.0–1.0	ND (0.24)	ND (0.24)	ND (0.25)	ND (0.62)
600782	CY81A-GR-022-SS	0.0–1.0	ND (0.24)	ND (0.24)	ND (0.25)	ND (0.62)
600782	CY81A-GR-023-SS	0.0–1.0	ND (0.24)	ND (0.24)	ND (0.25)	ND (0.62)
600782	CY81A-GR-024-DU	0.0–1.0	ND (0.24)	ND (0.24)	ND (0.25)	**0.8 J (2.14)**
600782	CY81A-GR-024-SS	0.0–1.0	ND (0.24)	ND (0.24)	ND (0.25)	ND (0.62)
600782	CY81A-GR-025-SS	0.0–1.0	ND (0.24)	ND (0.24)	ND (0.25)	ND (0.62)
600782	CY81A-GR-026-SS	0.0–1.0	ND (0.24)	ND (0.24)	ND (0.25)	**1.2 J (2.03)**
600782	CY81A-GR-027-SS	0.0–1.0	ND (0.24)	ND (0.24)	ND (0.25)	ND (0.62)
600782	CY81A-GR-028-SS	0.0–1.0	ND (0.24)	ND (0.24)	ND (0.25)	**1.3 J (2.01)**
Quality Assurance/Quality Control Samples (all in µg/L)						
600781	CY81A-GR-001-EB	NA	ND (0.4)	ND (0.7)	**1.2 J (5)**	ND (1.1)
600781	CY81A-GR-001-TB	NA	ND (0.4)	ND (0.7)	**2 J (5)**	ND (1.1)
600782	CY81A-GR-002-TB	NA	ND (0.4)	ND (0.7)	**4 J (5)**	ND (1.1)

Note: Values in **bold** represent detected VOCs.
[a]EPA November 1986.
[b]Analysis request/chain-of-custody record.

CY = Canyon.
DU = Duplicate sample.
EB = Equipment blank.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
GR = Grab sample.
ID = Identification.
J ( ) = The reported value is greater than or equal to the MDL but is less than the practical quantitation limit, shown in parentheses.
MDL = Method detection limit.
µg/kg = Microgram(s) per kilogram.
µg/L = Microgram(s) per liter.
NA = Not applicable.
ND = Not detected above the MDL, shown in parentheses.
SS = Surface soil sample.
SWMU = Solid Waste Management Unit.
TB = Trip blank.
VOC = Volatile organic compound.

Table 5.4.4-3
VOC Analytical Detection Limits
Used for SWMU 81A Baseline Soil Sampling
September 1998
(Off-Site Laboratory)

Analyte	Method Detection Limit (μg/kg)
1,1,1-Trichloroethane	0.18
1,1,2,2-Tetrachloroethane	0.46
1,1,2-Trichloroethane	0.24
1,1-Dichloroethane	0.2
1,1-Dichloroethene	0.25
1,2-Dichloroethane	0.23
1,2-Dichloropropane	0.23
2-Butanone	2.1
2-Hexanone	4.4
4-Methyl-2-pentanone	2.9
Acetone	2.2
Benzene	0.25
Bromodichloromethane	0.24
Bromoform	0.27
Bromomethane	0.67
Carbon disulfide	2.2
Carbon tetrachloride	0.22
Chlorobenzene	0.25
Chloroethane	0.72
Chloroform	0.24
Chloromethane	0.43
Dibromochloromethane	0.21
Ethyl benzene	0.23
Methylene chloride	0.25
Styrene	0.22
Tetrachloroethene	0.23
Toluene	0.22
Trichloroethene	0.27
Vinyl acetate	1.8
Vinyl chloride	0.4
Xylene (total)	0.62
Cis-1,2-dichloroethene	0.25
Cis-1,3-dichloropropene	0.25
Trans-1,2-dichloroethene	0.19
Trans-1,3-dichloropropene	0.22

μg/kg = Microgram(s) per kilogram.
SWMU = Solid Waste Management Unit.
VOC = Volatile organic compound.

Table 5.4.4-4
Summary of SWMU 81A Baseline Soil Sampling SVOC Analytical Results
September 1998
(Off-Site Laboratory)

Sample Attributes			Analyte (EPA Method 8270)[a] (µg/kg)
Record Number[b]	ER Sample ID (Figure 5.4.4-1)	Sample Depth (ft)	Diethylphthalate
600781	CY81A-GR-006-SS	0.0–1.0	ND (10)
600781	CY81A-GR-007-SS	0.0–1.0	ND (10)
600781	CY81A-GR-008-SS	0.0–1.0	ND (10)
600781	CY81A-GR-009-SS	0.0–1.0	**340**
600781	CY81A-GR-011-SS	0.0–1.0	**670**
600781	CY81A-GR-012-SS	0.0–1.0	ND (10)
600781	CY81A-GR-013-SS	0.0–1.0	ND (10)
600781	CY81A-GR-014-SS	0.0–1.0	ND (10)
600782	CY81A-GR-025-SS	0.0–1.0	ND (10)
600782	CY81A-GR-026-SS	0.0–1.0	ND (10)
600782	CY81A-GR-027-SS	0.0–1.0	ND (10)
600782	CY81A-GR-028-SS	0.0–1.0	ND (10)

Note: Values in **bold** represent detected SVOCs.
[a]EPA November 1986.
[b]Analysis request/chain-of-custody record.
CY = Canyon.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
GR = Grab sample.
ID = Identification.
MDL = Method detection limit.
µg/kg = Microgram(s) per kilogram.
ND ( ) = Not detected above the MDL, shown in parentheses.
SS = Surface soil sample.
SWMU = Solid Waste Management Unit.
SVOC = Semivolatile organic compound.

Table 5.4.4-5
SVOC Analytical Detection Limits
Used for SWMU 81A Baseline Soil Sampling
September 1998

Analyte	Method Detection Limit (μg/kg)
1,2,4-Trichlorobenzene	10
1,2-Dichlorobenzene	10
1,2-Diphenylhydrazine	10
1,3-Dichlorobenzene	10
1,4-Dichlorobenzene	10
2,4,5-Trichlorophenol	10
2,4,6-Trichlorophenol	10
2,4-Dichlorphenol	10
2,4-Dimethylphenol	10
2,4-Dinitrophenol	20
2,4-Dinitrotoluene	10
2,6-Dinitrotoluene	10
2-Chloronaphthalene	10
2-Chlorophenol	10
2-Methylnaphthalene	10
2-Nitroaniline	10
2-Nitrophenol	10
3,3'-Dichlorobenzidine	20
3-Nitroaniline	10
4-Bromophenyl phenyl ether	10
4-Chloro-3-methylphenol	10
4-Chlorobenzenamine	20
4-Chlorophenyl phenyl ether	10
4-Nitroaniline	10
4-Nitrophenol	10
Acenaphthene	10
Acenaphthylene	10
Anthracene	10
Benzo(a)anthracene	10
Benzo(a)pyrene	10
Benzo(b)fluoranthene	10
Benzo(g,h,i)perylene	10
Benzo(k)fluoranthene	10
Benzoic acid	50
Benzyl alcohol	10
Butylbenzyl phthalate	10
Chrysene	10
Di-n-butyl phthalate	10
Di-n-octyl phthalate	10
Dibenz(a,h)anthracene	10
Dibenzofuran	10
Diethylphthalate	10
Dimethylphthalate	10

Refer to footnotes at end of table.

Table 5.4.4-5 (Concluded)
Summary of SVOC Analytical Detection Limits
Used for SWMU 81A Baseline Soil Sampling
September 1998

Analyte	Method Detection Limit (µg/kg)
Dinitro-o-cresol	10
Fluoranthene	10
Fluorene	10
Hexachlorobenzene	10
Hexachlorobutadiene	10
Hexachlorocyclopentadiene	10
Hexachloroethane	10
Indeno(1,2,3-c,d)pyrene	10
Isophorone	10
Naphthalene	10
Nitrobenzene	10
Pentachlorophenol	20
Phenanthrene	10
Phenol	10
Pyrene	10
Bis(2-chloroethoxy)methane	10
Bis(2-chloroethyl)ether	10
Bis(2-ethylhexyl)phthalate	10
Bis-chloroisopropyl ether	10
m,p-Cresol	10
n-Nitrosodiphenylamine	10
n-Nitrosodipropylamine	10
o-Cresol	10

µg/kg = Microgram(s) per kilogram.
SVOC = Semivolatile organic compound.
SWMU = Solid Waste Management Unit.

Table 5.4.4-6
HE Analysis Detection Limits
Used for SWMU 81A Baseline Soil Sampling
September 1998
(Off-Site Laboratory)

Analyte	Method Detection Limit (μg/kg)
1,3,5-Trinitrobenzene	6.6
1,3-Dinitrobenzene	4.1
2,4,6-Trinitrotoluene	5.7
2,4-Dinitrotoluene	6.2
2,6-Dinitrotoluene	6.5
2-Amino-4,6-dinitrotoluene	6.6
2-Nitrotoluene	7.8
3-Nitrotoluene	11
4-Amino-2,6-dinitrotoluene	5.5
4-Nitrotoluene	11
HMX	5.3
Nitrobenzene	5.2
RDX	9.7
Tetryl	7.5

HE = High explosive(s).
HMX = 1,3,5,7-Tetranitro-1,3,5,7-tetrazacyclooctane.
μg/kg = Microgram(s) per kilogram.
RDX = 1,3,5-Trinitro-1,3,5-triazacyclohexane.
SWMU = Solid Waste Management Unit.
Tetryl = 2,4,6-Trinitrophenylmethylnitramine.

Table 5.4.4-7
Summary of SWMU 81A Baseline Soil Sampling Gamma Spectroscopy Analytical Results
September 1998
(On-Site Laboratory)

Sample Attributes			Activity (pCi/g)							
Record Number[a]	ER Sample ID (Figure 5.4.4-1)	Sample Depth (ft)	Cesium-137 Result	Cesium-137 Error[b]	Thorium-232 Result	Thorium-232 Error[b]	Uranium-235 Result	Uranium-235 Error[b]	Uranium-238 Result	Uranium-238 Error[b]
600811	CY81A-GR-001-SS	0.0–1.0	0.0289	0.0132	0.354	0.225	0.144	0.153	0.729	0.312
600811	CY81A-GR-002-SS	0.0–1.0	0.0219	0.0186	0.524	0.271	ND (0.188)	--	0.455	0.352
600811	CY81A-GR-003-SS	0.0–1.0	0.0489	0.0227	0.609	0.299	0.127	0.180	1.81	0.437
600811	CY81A-GR-004-SS	0.0–1.0	0.0756	0.0310	0.688	0.346	0.0785	0.0769	0.377	0.425
600811	CY81A-GR-005-SS	0.0–1.0	ND (0.0283)	--	0.529	0.293	0.107	0.0450	0.558	0.318
600811	CY81A-GR-006-SS	0.0–1.0	0.0626	0.0247	0.835	0.407	ND (0.249)	--	0.659	0.507
600811	CY81A-GR-007-SS	0.0–1.0	0.0492	0.0380	0.657	0.326	ND (0.223)	--	0.697	0.412
600811	CY81A-GR-008-SS	0.0–1.0	0.0388	0.0190	0.664	0.329	ND (0.228)	--	0.676	0.397
600811	CY81A-GR-009-SS	0.0–1.0	ND (0.0363)	--	1.02	0.505	ND (0.251)	--	0.475	0.411
600811	CY81A-GR-010-SS	0.0–1.0	0.0781	0.0446	0.774	0.372	ND (0.233)	--	0.801	0.557
600811	CY81A-GR-011-SS	0.0–1.0	ND (0.0153)	--	0.579	0.937	ND (0.204)	--	0.837	0.542
600811	CY81A-GR-012-SS	0.0–1.0	0.0163	0.0126	0.85	0.417	ND (0.234)	--	0.449	0.360
600811	CY81A-GR-013-SS	0.0–1.0	0.0196	0.0150	0.558	0.929	ND (0.188)	--	ND (0.653)	--
600811	CY81A-GR-014-SS	0.0–1.0	0.0292	0.0293	0.671	0.338	**0.184**	0.176	0.725	0.449
600811	CY81A-GR-015-SS	0.0–1.0	0.0459	0.0253	0.678	0.361	**0.316**	0.194	0.828	0.620
600811	CY81A-GR-016-SS	0.0–1.0	0.0368	0.0184	0.747	0.360	0.130	0.105	0.675	0.572
600811	CY81A-GR-017-SS	0.0–1.0	0.0267	0.0220	0.999	0.481	ND (0.249)	--	0.690	0.464
600812	CY81A-GR-018-SS	0.0–1.0	ND (0.0385)	--	0.834	0.424	ND (0.208)	--	1.01	0.381
600812	CY81A-GR-019-SS	0.0–1.0	0.0187	0.0451	0.695	0.397	ND (0.197)	--	ND (0.640)	--
600812	CY81A-GR-020-SS	0.0–1.0	ND (0.0369)	--	0.758	0.373	**0.183**	0.168	0.589	0.460
600812	CY81A-GR-021-SS	0.0–1.0	0.0102	0.0415	0.961	0.484	**0.316**	0.170	ND (0.638)	--
600812	CY81A-GR-022-SS	0.0–1.0	0.0122	0.0191	0.881	0.424	ND (0.0903)	--	0.579	0.359
600812	CY81A-GR-023-SS	0.0–1.0	0.0409	0.0267	0.675	0.411	0.117	0.151	0.796	0.422
600812	CY81A-GR-024-SS	0.0–1.0	0.0215	0.0316	1.02	0.530	ND (0.203)	--	0.978	0.402
600812	CY81A-GR-024-DU	0.0–1.0	0.0323	0.0344	0.898	0.525	**0.169**	0.169	0.969	0.775
600812	CY81A-GR-025-SS	0.0–1.0	0.2020	0.2390	**1.15**	0.599	**0.174**	0.201	1.40	0.585
600812	CY81A-GR-026-SS	0.0–1.0	0.0784	0.0448	1.02	0.516	0.0817	0.185	1.06	0.733
600812	CY81A-GR-027-SS	0.0–1.0	0.0806	0.0392	**1.05**	0.498	ND (0.235)	--	1.08	0.440

Refer to footnotes at end of table.

Table 5.4.4-7 (Concluded)
Summary of SWMU 81A Baseline Soil Sampling Gamma Spectroscopy Analytical Results
September 1998
(On-Site Laboratory)

Sample Attributes			Activity (pCi/g)							
Record Number[a]	ER Sample ID (Figure 5.4.4-1)	Sample Depth (ft)	Cesium-137		Thorium-232		Uranium-235		Uranium-238	
			Result	Error[b]	Result	Error[b]	Result	Error[b]	Result	Error[b]
600812	CY81A-GR-028-SS	0.0–1.0	0.0519	0.0228	0.744	0.409	**0.162**	0.147	ND (0.541)	--
Background Soil Activities—Canyons Area[c]			0.515	NA	1.03	NA	0.16	NA	2.31	NA

Note: Values in **bold** exceed background soil activities.
[a]Analysis request/chain-of-custody record.
[b]Two standard deviations about the mean detected activity.
[c]From Dinwiddie September 1997.
CY = Canyon.
DU = Duplicate.
ER = Environmental Restoration.
ft = Foot (feet).
GR = Grab sample.
ID = Identification.
NA = Not applicable.
ND ( ) = Not detected above the minimum detectable activity, shown in parentheses.
pCi/g = Picocurie(s) per gram.
SS = Surface soil sample.
SWMU = Solid Waste Management Unit.
-- = Error not calculated for nondetectable results.

Table 5.4.4-8
Summary of SWMU 81A Baseline Soil Sampling Gross Alpha and Beta Analyses
September 1998
(Off-Site Laboratory)

Sample Attributes			Activity (pCi/g)			
			Gross Alpha		Gross Beta	
Record Number[a]	ER Sample ID (Figure 5.4.4-1)	Sample Depth (ft)	Result	Error[b]	Result	Error[b]
600781	CY81A-GR-001-SS	0.0–1.0	5.57	3.39	12.3	3.47
600781	CY81A-GR-002-SS	0.0–1.0	8.95	3.31	16.2	3.62
600781	CY81A-GR-003-SS	0.0–1.0	12	3.68	19.9	3.75
600781	CY81A-GR-004-SS	0.0–1.0	12.4	3.87	15.3	3.23
600781	CY81A-GR-005-SS	0.0–1.0	12.7	3.99	15.9	3.55
600781	CY81A-GR-006-SS	0.0–1.0	9.48	3.38	19.6	3.92
600781	CY81A-GR-007-SS	0.0–1.0	9.72	3.2	23.6	3.93
600781	CY81A-GR-008-SS	0.0–1.0	**20.2**	5.37	21.3	3.91
600781	CY81A-GR-009-SS	0.0–1.0	13	3.59	17.7	3.67
600781	CY81A-GR-010-SS	0.0–1.0	8.54	3.11	18.2	3.52
600781	CY81A-GR-011-SS	0.0–1.0	9.8	3.39	18.2	3.83
600781	CY81A-GR-012-SS	0.0–1.0	8.49	3.15	19	3.72
600781	CY81A-GR-013-SS	0.0–1.0	10	3.29	15.7	3.47
600781	CY81A-GR-014-SS	0.0–1.0	14.2	3.87	11.2	3.28
600781	CY81A-GR-015-SS	0.0–1.0	15.3	4.82	15	3.38
600781	CY81A-GR-016-SS	0.0–1.0	12.5	3.82	20.9	3.91
600781	CY81A-GR-017-SS	0.0–1.0	14.2	3.89	21.6	3.8
600782	CY81A-GR-018-SS	0.0–1.0	16.7	5.19	22.9	4.73
600782	CY81A-GR-019-SS	0.0–1.0	12.8	4.85	20.8	4.49
600782	CY81A-GR-020-SS	0.0–1.0	**18.7**	5.67	20.4	4.52
600782	CY81A-GR-021-SS	0.0–1.0	16.8	5.37	22	4.68
600782	CY81A-GR-022-SS	0.0–1.0	14.2	4.99	25.3	4.73
600782	CY81A-GR-023-SS	0.0–1.0	**26.4**	7.24	27.6	5.65
600782	CY81A-GR-024-DU	0.0–1.0	12.6	4.42	22.4	4.32
600782	CY81A-GR-024-SS	0.0–1.0	13.2	4.96	27.6	4.77
600782	CY81A-GR-025-SS	0.0–1.0	**20.8**	5.97	23.8	4.46
600782	CY81A-GR-026-SS	0.0–1.0	**18.8**	5.94	30.3	5
600782	CY81A-GR-027-SS	0.0–1.0	13.5	4.82	16.6	4.35
600782	CY81A-GR-028-SS	0.0–1.0	11.5	4.68	26.8	4.94
Background Soil Activities—Canyons Area[c]			18.3	NA	52.7	NA

[a]Analysis request/chain-of-custody record.
[b]Two standard deviations about the mean detected activity.
[c]From Tharp July 1998.

CY = Canyon.
DU = Duplicate sample.
ER = Environmental Restoration.
ft = Foot (feet).
GR = Grab sample.
ID = Identification.
NA = Not applicable.
pCi/g = Picocurie(s) per gram.
SS = Surface soil sample.
SWMU = Solid Waste Management Unit.

Bromodichloromethane was detected in two samples (CY81A-GR-013-SS and CY81A-GR-015-SS), at concentrations of 1.3 μg/kg and 0.96 J μg/kg, respectively. Chloroform was detected in seven samples (CY81A-GR-013-SS, CY81A-GR-014-SS, CY81A-GR-015-SS, CY81A-GR-016-SS, CY81A-GR-017-SS, CY81A-GR-018-SS, and CY81A-GR-019-SS), ranging in concentration from 2.5 μg/kg to 5.1 μg/kg. Xylene was detected at estimated concentrations in five samples (CY81A-GR-009-SS, CY81A-GR-013-SS, CY81A-GR-024-DU, CY81A-GR-026-SS, and CY81A-GR-028-SS), ranging in concentration from 0.8 J μg/kg to 1.3 J μg/kg.

Table 5.4.4-3 summarizes the detection limits used for analyzing VOCs by the off-site laboratory.

SVOCs

Because there are no applicable background concentrations for SVOCs in soil, any detectable SVOCs in the samples collected at SWMU 81A are considered an indicator of contamination. One SVOC (diethyl phthalate) was detected in two samples at SWMU 81A. The following briefly describes the SVOC analytical results.

Table 5.4.4-4 summarizes the off-site SVOC analysis for the 12 soil samples analyzed for SVOCs. Diethyl phthalate was detected in two samples (CY81A-GR-009-SS and CY81A-GR-011-SS), at concentrations of 340 μg/kg and 670 μg/kg, respectively.

Table 5.4.4-5 summarizes the detection limits used for analyzing SVOCs by the off-site laboratory.

HE

Because there are no applicable background concentrations for HE in soil any detectable HE in the samples collected at SWMU 81A may be considered an indicator of contamination. Of the 28 soil samples collected and analyzed for HE, the results for 12 of the samples (CY81A-GR-018-SS through CY81A-GR-028-SS and one duplicate) were qualified as "nondetect estimated" during data validation (Section 5.4.4.3) due to missed holding times. Therefore, the areas around the Catcher Box and Gun Firing Site 1 cannot be directly evaluated for the presence of HE compounds with the existing data. However, no HE compounds were detected in any of the remaining 16 samples analyzed. These samples were collected along both sides of the Sled Track and surrounding Gun Firing Sites 2 and 3.

The results from the 16 sampling locations allow an evaluation to be made on the probability for HE to be present at the Catcher Box and Gun Firing Site 1. Since no HE was detected along the length of the Sled Track or around Gun Firing Sites 2 and 3 it is unlikely that it would be present at the Catcher Box or Gun Firing Site 1 locations, where similar activities were conducted. Statistically 57 percent of the samples were analyzed for HE and no HE was detected. Additionally, HE was analyzed for at SWMUs 81B (23 samples), 81C (54 samples), 81D (22 samples), and 81F (36 samples) and only very minor detections of HE (four out of 135 samples) were noted, all at concentrations less than 1.11 mg/kg. None of the HE detected at the other sites were at levels that posed a risk to human health or the environment during the risk screening. Therefore, the HE data collected at SWMU 81A is believed adequate to characterize the potential for HE contamination at the site and has demonstrated that HE contamination is not present at SWMU 81A.

Table 5.4.4-6 summarizes the detection limits used for analyzing HE compounds by the off-site laboratory.

<u>Radionuclides</u>

Table 5.4.4-7 summarizes the on-site gamma spectroscopy analysis results for the 28 soil samples and one duplicate sample collected at SWMU 81A. Gamma activity attributable to thorium-232 was detected slightly above the 1.03 picocuries per gram (pCi/g) background level in two samples (CY81A-GR-025-SS, and CY81A-GR-027-SS), the activities were 1.15 pCi/g and 1.05 pCi/g. Uranium-235 activity was above the 0.16 pCi/g background level in seven samples (CY81A-GR-014-SS, CY81A-GR-015-SS, CY81A-GR-020-SS, CY81A-GR-021-SS, CY81A-GR-024-DU, CY81A-GR-025-SS, and CY81A-GR-028-SS), the activities ranged from 0.162 pCi/g to 0.316 pCi/g. However, the minimum detectable activity (MDA) associated with nondetectable results for uranium-235 exceeded background in half of the samples. Although this situation inhibits any comparison to background, uranium-238 and uranium-235 results can be compared because both coexist in depleted uranium. As a result, any elevated uranium-238 activity would be accompanied by a corresponding elevation in uranium-235 activity. Using this comparison, the nondetectable results obtained for uranium-235 that have MDAs above background in the samples do not show corresponding elevated activities in the results for uranium-238. Gamma activity attributable to uranium-238 and cesium-137 was either not detected above the MDA or was not detected above background. Refer to Annex 5-A for all radionuclide data.

<u>Gross Alpha and Gross Beta</u>

Table 5.4.4-8 summarizes the off-site gross alpha and gross beta analyses results for 28 soil samples and one duplicate sample collected. Gross beta activity did not exceed background in any of the samples that were analyzed. Gross alpha activity slightly exceeded the background level of 18.3 pCi/g in five samples (CY81A-GR-008-SS, CY81A-GR-020-SS, CY81A-GR-023-SS, CY81A-GR-025-SS, and CY81A-GR-026-SS), the activities ranged from 18.7 pCi/g to 26.4 pCi/g.

5.4.4.3 Data Quality

<u>QA/QC Results</u>

Tables 5.4.4-1, 5.4.4-2, and 5.4.4-4 presented results of the analyses of metal, VOC, and SVOC QA/QC samples that were collected during the baseline sampling program at SWMU 81A. These QA/QC samples consisted of one equipment blank and two trip blanks. The equipment blank was analyzed off site for metals, VOCs, and HE, and the trip blanks were analyzed for VOCs. Methylene chloride was detected at low estimated concentrations in the equipment blank and the two trip blanks. One HE compound, dinitrobenzene, was detected at a very low concentration in the equipment blank, but the data was rejected due to missing the holding time. No HE was detected in the samples associated with the equipment blank, so no data had to be

qualified. Metal concentrations in the equipment blank were less than detection limits for all analytes except barium, chromium, and silver. The concentrations were below the practical quantitation limit and were qualified J (estimated value). No QA/QC samples were collected for radionuclide analyses.

To assess the precision of soil sampling procedures, one soil sample was collected and analyzed in replicate off site. Relative percent differences (RPD) were calculated from the data and are shown in Table 5.4.4-9. Because some results for the sample pair are nondetect, RPDs could not be calculated for mercury and silver. The corresponding RPDs were 1.2 percent for arsenic, 1.9 percent for barium, 0.6 percent for beryllium, 10.1 percent for cadmium, 3.7 percent for chromium, 9.6 percent for lead, and 13.6 percent for selenium in the sample duplicate pair. All of the results obtained for the sample duplicate pair are in good agreement for an inhomogeneous soil matrix.

Data Validation

All off-site laboratory results were reviewed and verified/validated according to "Data Validation Procedure for Chemical and Radiochemical Data," SNL/NM Environmental Restoration Project Analytical Operating Procedure 00-03, Rev. 0 (SNL/NM December 1999). In addition, SNL/NM Department 7713 (RPSD Laboratory) reviewed all gamma spectroscopy results according to "Laboratory Data Review Guidelines," Procedure No. RPSD-02-11, Issue No. 2 (SNL/NM July 1996). The verification/validation process confirmed that the data are acceptable for use in this NFA proposal for SWMU 81A. See Annex 5-B for the off-site data validation reports.

During data validation, qualifications were applied to VOC sample data due to trip, equipment, and method blank contamination and exceeded holding times. Methylene chloride was detected in the method blank, the equipment blank, and the trip blank at levels above the practical quantitation limit. The blank contamination affected 16 samples that were qualified as "non-detect." In addition, one sample was analyzed one day past the prescribed holding time, and the results were qualified as estimated, non-detect. Four SVOCs did not meet acceptance criteria, and the results were qualified as estimated, nondetect. The HE analysis of 12 samples was performed seven days past the prescribed holding time, and the results were qualified estimated, non-detect. The HE results for the equipment blank were rejected because the analysis was not performed at the same time as the required quality control. The amount of selenium detected in 12 samples was estimated because the concentration was less than five times the calibration blank value. Because silver was detected in the blanks, the concentration in 12 samples were estimated. The concentration of arsenic in the equipment blank was rejected because it was found in the continuing calibration blank.

5.5 Site Conceptual Model

The site conceptual model for SWMU 81A is based upon residual COCs identified in the soil samples collected from throughout the site. This section summarizes the nature and extent of contamination and the environmental fate of COCs.

Table 5.4.4-9
Summary of SWMU 81A Field Duplicate Relative Percent Differences

Sample Attributes			Relative Percent Difference						
Record Number[a]	ER Sample ID (Figure 5.4.4-1)	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Selenium
600782	CY81A-GR-024-SS CY81A-GR-024-DU (off-site laboratory)	0.0–1.0	1.2	1.9	0.6	10.1	3.7	9.6	13.6

[a]Analysis request/chain-of-custody record.
CY = Canyon.
DU = Duplicate sample.
ER = Environmental Restoration.
ft = Foot (feet).
GR = Grab sample.
ID = Identification.
SS = Surface soil sample.
SWMU = Solid Waste Management Unit.

5.5.1 Nature and Extent of Contamination

The primary COCs at SWMU 81A are a few metals that may be associated with past testing at the site. Low concentrations of three VOCs and one SVOC, many of which are estimated concentrations, were also detected in a few samples. Gamma activities attributable to thorium-232 and uranium-235 were detected above background in a few samples. Gross alpha activity was detected above background in a few samples. Metal and radionuclide COCs were determined by comparing sample results to background concentrations and to activities established for the Canyons Area (Dinwiddie September 1997, Garcia November 1998). Any metal or radionuclide found to exceed background in any sample is considered a potential COC for the site. Because the MDAs for uranium-235 analyses exceed background activity limits in some samples (see Table 5.4.4-7), those non-detect sample results are also considered in identifying potential COCs. In the case of radionuclides, the MDA is used for comparison to background. As a result, metal COCs include beryllium, cadmium, chromium, and lead. Radionuclide COCs include thorium-232, uranium-235, and gross alpha. Table 5.5.1-1 lists the COCs and the sample locations where they were detected.

Twenty-eight samples and one duplicate sample were collected from the area surrounding the Catcher Box/Sled Track and Gun Sites 1, 2, and 3 at SWMU 81A. In most cases, the COCs are only slightly elevated above background concentrations or activity limits specified for the Canyons Area (Dinwiddie September 1997, Garcia November 1998). The COCs that exceed background limits typically occur as isolated "hot spots," with no particular COC associations or correlation to particular locations that could be delineated as contaminated. The exceptions to this are the elevated concentrations of beryllium and lead. Beryllium was elevated in three of four samples from Gun Firing Site 4. Lead was elevated in three of four samples from Gun Firing Site 2.

Potential COCs were determined on the basis of detectable concentrations of VOCs and SVOCs in any soil sample. Because background concentrations for these constituents are not applicable, any detectable VOCs or SVOCs are considered potential contamination. Conversely, analytical results of samples that yielded no detections were not considered in evaluating potential COCs at SWMU 81A. As a result, VOC COCs included bromodichloromethane, chloroform, and xylene. The SVOC COC is diethyl phthalate. Table 5.5.1-1 lists these COCs and the sample locations where they were detected.

Because the concentrations of most of the VOCs detected were below the laboratory practical quantitation limit, they were qualified as estimated values. The concentrations do not vary much with sample location, so it is believed that the VOCs do not result from contamination from activities conducted at SWMU 81A. Also, the locations of the SVOC detection are sporadic, and the SVOC is a common sample handling contaminant; thus, it is believed that the SVOC did not result from contamination from activities conducted at SWMU 81A.

The MDA associated with most non-detectable results for uranium-235 analyses were above background, and seven samples had activities above background. Thorium-232 was detected above the maximum background activity at two sample locations. All elevated activities are believed to be naturally occurring at SWMU 81A due to the natural characteristic of the rock and soil in the area (RUST Geotech Inc. December 1994)

Table 5.5.1-1
Summary of COCs for SWMU 81A

COC Type	Number of Samples	COCs Greater Than Background	Maximum Background Limit/Canyons Area[a] (mg/kg, except where noted)	Maximum Concentration (mg/kg, except where noted)	Average Concentration[b] (mg/kg, except where noted)	Sampling Locations Where Background Concentration Exceeded[c]
Metals	28 environmental, 1 duplicate	Beryllium	0.75	1.1	0.62	CY81A-GR-012-SS CY81A-GR-025-SS CY81A-GR-026-SS CY81A-GR-027-SS
		Cadmium	0.64	0.76	0.17	CY81A-GR-019-SS CY81A-GR-024-DU CY81A-GR-024-SS
		Chromium	18.8	20.6	13.42	CY81A-GR-023-SS CY81A-GR-026-SS
		Lead	18.9	35.5	15.82	CY81A-GR-012-SS CY81A-GR-013-SS CY81A-GR-014-SS CY81A-GR-023-SS CY81A-GR-024-SS
VOCs	28 environmental, 1 duplicate	Bromodichloromethane	NA	1.3 μg/kg	Not calculated	CY81A-GR-013-SS CY81A-GR-015-SS
		Chloroform	NA	5.1 μg/kg	Not calculated	CY81A-GR-013-SS CY81A-GR-014-SS CY81A-GR-015-SS CY81A-GR-016-SS CY81A-GR-017-SS CY81A-GR-018-SS CY81A-GR-019-SS
		Xylene	NA	1.3 J μg/kg	Not calculated	CY81A-GR-009-SS CY81A-GR-013-SS CY81A-GR-024-SS CY81A-GR-026-SS CY81A-GR-028-SS
SVOCs	28 environmental, 1 duplicate	Diethyl phthalate	NA	670 μg/kg	Not calculated	CY81A-GR-009-SS CY81A-GR-011-SS

Refer to footnotes at end of table.

Table 5.5.1-1 (Concluded)
Summary of COCs for SWMU 81A

COC Type	Number of Samples	COCs Greater Than Background	Maximum Background Limit/Canyons Area[a] (mg/kg except where noted)	Maximum Concentration (mg/kg except where noted)	Average Concentration[b] (mg/kg except where noted)	Sampling Locations Where Background Concentration Exceeded[c]
Radionuclides	28 environmental, 1 duplicate	Th-232	1.03 pCi/g	1.15 pCi/g	Not calculated[d]	CY81A-GR-025-SS CY81A-GR-027-SS
		U-235	0.16 pCi/g	0.316	Not calculated[d]	CY81A-GR-014-SS CY81A-GR-015-SS CY81A-GR-020-SS CY81A-GR-021-SS CY81A-GR-024-DU CY81A-GR-025-SS CY81A-GR-028-SS

[a]From Garcia November 1998 (for metals); from Dinwiddie September 1997 (for radionuclides).
[b]Average concentration includes all samples. For nondetectable results, the detection limit is used to calculate the average.
[c]Includes all samples with detectable concentrations (for VOCs and SVOCs) or all samples with nondetectable results where the MDA exceeds background (for radionuclides).
[d]An average MDA is not calculated because of the variability in instrument counting error and the number of reported nondetectable activities.

COC = Constituent of concern.
CY = Canyon.
DU = Duplicate sample.
GR = Grab sample.
J = Analytical result was qualified as an estimation.
µg/kg = Micrograms per kilogram.
MDA = Minimum detectable activities.
mg/kg = Milligram(s) per kilogram.
NA = Not applicable.
pCi/g = Picocurie(s) per gram.
SS = Surface soil sample.
SVOC = Semivolatile organic compound.
SWMU = Solid Waste Management Unit.
VOC = Volatile organic compound.

5.5.2 Environmental Fate

The primary source of COCs at SWMU 81A was from the gun firing sites, sled track, and catcher box activities (Figure 5.5.2-1). The primary release mechanism of COCs to the surface and subsurface soil was from deposition of rocket motors and metallic debris on the surface from the testing activities conducted at the site. SWMU 81A is on a west-facing slope above the floor of Sol se Mete Canyon. During intense rainfall events surface runoff can actively erode the site and could be considered a release mechanism

Table 5.5.1-1 summarizes potential COCs for SWMU 81A. Based upon the nature and extent of contamination at the site (Section 5.5.1), metals, VOCs, and SVOCs occur sporadically at low concentrations in surface soil around the site. No distinct vertical or horizontal distribution of contamination is present. As discussed in Section 5.5.1, radionuclides are also potential COCs for SWMU 81A. All potential COCs were retained in the conceptual model and were evaluated in the human health and ecological risk assessments.

The current land use for SWMU 81A is industrial. However, because the future land use for SWMU 81A is recreational (DOE et al. October 1995), the potential human receptor is considered a recreational user of the site. For all applicable pathways, the exposure route for the recreational user is dermal contact and ingestion/inhalation. Only ingestion of soil is considered a major exposure route for the recreational user. Potential biota receptors include flora and fauna at the site. Similar to the recreational user, direct ingestion of soil is considered the major exposure route for biota, in addition to ingestion through food chain transfers or direct uptake. Annex 5-C, Section V, provides additional discussion of the exposure routes and receptors at SWMU 81A.

5.6 Site Assessments

Site assessment at SWMU 81A includes risk screening assessments followed by risk baseline assessments (as required) for both human health and ecological risk. The following sections summarize the site assessment results. Annex 5-C provides details of the site assessment.

5.6.1 Summary

The site assessment concludes that SWMU 81A has no significant potential to affect human health under a recreational land use scenario. After considering the uncertainties associated with the available data and modeling assumptions, ecological risks associated with SWMU 81A were found to be very low. Section 5.6 briefly describes and Annex 5-C provides details of the site screening assessments.

5.6.2 Screening Assessments

Risk screening assessments were performed for both human health risk and ecological risk for SWMU 81A. This section briefly summarizes the risk screening assessments.

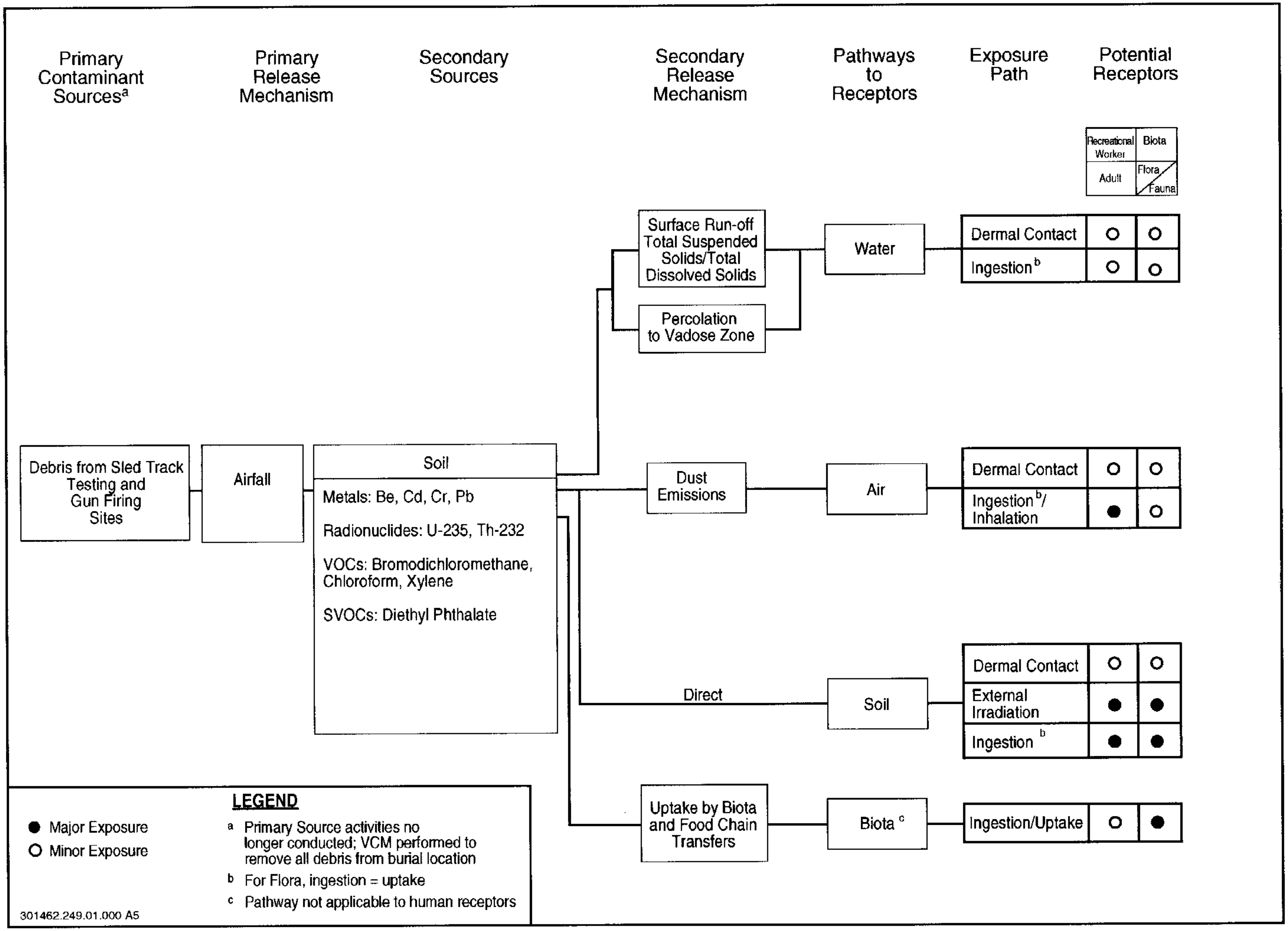

Figure 5.5.2-1

Conceptual Model Flow Diagram for SWMU 81A, Catcher Box/Sled Track

5.6.2.1 *Human Health*

SWMU 81A has been recommended for recreational land use (DOE et al. October 1995). Annex 5-C provides a complete discussion of the risk assessment process, results, and uncertainties. Because COCs are present in concentrations or activities greater than background levels, it was necessary to perform a health risk assessment analysis for the site. This assessment included any detected VOCs or SVOCs and any radionuclide compounds detected either above background levels and/or above MDAs. The risk assessment process provides a quantitative evaluation of the potential adverse human health effects caused by constituents in the site's soil. The Risk Assessment Report calculated the hazard index (HI) and excess cancer risk for a recreational land use setting. The excess cancer risk from nonradiological COCs and the radiological COCs is not additive (EPA 1989).

In summary, the HI calculated for SWMU 81A nonradiological COCs for a recreational land use setting is 0.00, which is less than the numerical standard of 1.0 suggested by risk assessment guidance (EPA 1989). Incremental risk is determined by subtracting risk associated with background from potential nonradiological COC risk. The incremental HI is 0.00. The excess cancer risk for SWMU 81A nonradiological COCs is 4E-9 for a recreational land use setting. Guidance from the NMED indicates that excess lifetime risk of developing cancer by an individual must be less than 1E-6 for Class A and B carcinogens and less than 1E-5 for Class C carcinogens (NMED March 1998). Thus, the excess cancer risk for this site is below the suggested acceptable risk value (1E-6). The incremental excess cancer risk is 3.78E-9.

The incremental total effective dose equivalent for radionuclides for a recreational land use setting for SWMU 81A is 4.4E-2 millirems (mrem)/year (yr), which is well below the recommended dose limit of 15 mrem/yr found in EPA's OSWER Directive No. 9200.4-18 (1997a) and reflected in a document entitled, "Sandia National Laboratories/New Mexico Environmental Restoration Project—RESRAD Input Parameter Assumptions and Justification" (SNL/NM February 1998). The incremental excess cancer risk for the radionuclides for the recreational land-use scenario is 7.5E-7, which is much less than risk values calculated from naturally occurring radiation and from intakes considered as background concentration values.

The residential land use scenarios for this site are provided only for comparison in the Risk Assessment Report (Annex 5-C). The report concludes that SWMU 81A does not have potential to affect human health under a recreational land use scenario.

5.6.2.2 *Ecological*

An ecological screening assessment that corresponds with the screening procedures (NMED March 1998) in the EPA's Ecological Risk Assessment Guidance for Superfund (EPA 1997b) was performed as set forth by the NMED Risk-Based Decision Tree. An early step in the evaluation compared COC concentrations and identified potentially bioaccumulative constituents (see Annex 5-C, Sections III, VI, VII.2, and VII.3). This methodology also required developing a site conceptual model and a food web model, as well as selecting ecological receptors. Each of these items was presented in the "Predictive Ecological Risk Assessment Methodology for SNL/NM ER Program, Sandia National Laboratories/New Mexico" (IT July 1998) and will not be duplicated here. The screening also includes the estimation of exposure and ecological risk.

Tables 15, 16, 17, and 18 of Annex 5-C present the results of the ecological risk assessment screen. Site-specific information was incorporated into the screening assessment when such data were available. Hazard quotients greater than unity were originally predicted; however, closer examination of the exposure assumptions revealed an overestimation of risk primarily attributed to exposure concentration (maximum COC concentration was used in estimating risk), exposure setting (area use factors of one were assumed), and background risk. Based upon an evaluation of these uncertainties, ecological risks associated with this site are expected to be very low.

5.6.3 Baseline Risk Assessments

This section discusses the baseline risk assessments for human health and ecological risk.

5.6.3.1 Human Health

Based upon the fact that human health results of the screening assessment summarized in Section 5.6.2.1 indicate that SWMU 81A does not have potential to affect human health under a recreational land use setting, a baseline human health risk assessment is not required for SWMU 81A.

5.6.3.2 Ecological

Based upon the fact that ecological results of the screening assessment summarized in Section 5.6.2.2 indicate that SWMU 81A has very low ecological risk, a baseline ecological risk assessment is not required for SWMU 81A.

5.6.4 Other Applicable Assessments

A Surface Water Site Assessment was conducted at SWMU 81A in August 1998 (SNL/NM August 1998). The surface water assessment guidance was developed jointly by Los Alamos National Laboratory and the NMED Surface Water Quality Bureau. The assessment evaluated the potential for erosion from SWMU 81A. SWMU 81A received a score of 65.5 indicating that it has high erosion potential. The high erosion potential is due to its location on the steep west facing bank of Sol se Mete Canyon and the fact that access roads exist on both sides of the Sled Track so native vegetation is scarce. Although the graded portions of the site may be subject to some erosion during significant rainstorm events no localized areas of contamination were found at the site during baseline sampling. The few COCs detected at the site were at scattered locations (Table 5.5.1-1) primarily in the upper portions of the slope, indicating that surface water runoff is not causing contaminant migration at SWMU 81A. Additionally, as discussed under the Results and Conclusions (Section 5.4.4.2.2) and Screening Assessments (Section 5.6) sections, COCs detected are not at levels that pose a threat to human health or the environment or could adversely affect surface water quality.

5.7 No Further Action Proposal

5.7.1 Rationale

Based upon field investigation data and the human health risk assessment analysis, an NFA is recommended for SWMU 81A because no COCs (particularly VOCs, SVOCs, or radionuclides) were present in concentrations considered hazardous to human health for a recreational land use scenario.

5.7.2 Criterion

Based upon the evidence provided above, SWMU 81A is proposed for an NFA decision in conformance with Criterion 5 (NMED March 1998), which states, "The SWMU/AOC has been characterized or remediated in accordance with current applicable state or federal regulations, and that available data indicate that contaminants pose an acceptable level of risk under current and projected future land use."

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ANNEX 5-C
Risk Screening Assessment

TABLE OF CONTENTS

LIST OF TABLES

SWMU 81A: RISK SCREENING ASSESSMENT REPORT

I. Site Description and History

Solid Waste Management Unit (SWMU) 81A is a subunit of SWMU 81 identified as the New Aerial Cable Facility on the Resource Conservation and Recovery Act (RCRA) Hazardous and Solid Waste Amendment permit. SWMU 81A is located on U.S. Air Force (USAF) land withdrawn from the U.S. Forest Service and permitted to the U.S. Department of Energy (DOE). The site is located on a western sloping hillside on the east side of Sol se Mete Canyon. The Sol se Mete Canyon drains to the north into Lurance Canyon, which in turn drains to the west to Arroyo del Coyote. Coyote Springs Road follows the drainage of Lurance Canyon and is the main access to the service road in Sol se Mete Canyon. SWMU 81A is an inactive subunit. Testing activities at the Aerial Cable Facility include gravitational accelerated (drop) tests and rocket sled pull-down tests. The rocket pull-down technique uses towing cables to accelerate rocket sleds carrying the test items. The test items are released from the overhead cable as the rockets are ignited and directed toward a target, which is usually located on the canyon floor.

Historical published information regarding the hydrogeology of Sol se Mete and Lurance Canyon has been summarized in the "RCRA Facility Investigation (RFI) Work Plan for the Operable Unit (OU) 1333, Canyons Test Area" (SNL/NM September 1995). Since that time, additional bedrock wells and alluvial piezometers have been installed in the Lurance Canyon, and data collected from the new bedrock wells have supported the hydrologic model of semiconfined to confined groundwater conditions at a depth of approximately 150 feet below ground surface (bgs) beneath the Lurance Canyon SWMUs. The data collected from the alluvial piezometers support the absence of alluvial groundwater. Hydrologic data have been based upon the Burn Site Well, CYN-MW1D, 12AUP01 (piezometer), CYN-MW2S (piezometer), CYN-MW3, and CYN-MW4.

In summary, the groundwater beneath the floor of Sol se Mete Canyon occurs at depths of at least 222 feet bgs under semiconfined to confined conditions in fractured metamorphic rock. There has been no record to date of shallow groundwater occurring in the alluvium overlying the bedrock.

For a detailed discussion regarding the local setting at SWMU 81A, refer to the "RFI Work Plan for OU 1333, Canyons Test Area" (SNL/NM September 1995).

Construction of the New Aerial Cable Site, SWMU 81, began in 1970 in response to the need to upgrade the aerial cable facilities that existed at the Old Aerial Cable Site (SWMU 82) (SNL/NM September 1995). The new aerial cable facilities provide impact testing on weapons and other test units that could be subjected to detonation (SNL/NM September 1995). The initial construction activity at SWMU 81 was at the southern cable area and included the placement of the aerial cable anchors on the ridge crests east and west of Sol se Mete Canyon.

A 1971 historical aerial photograph shows that SWMU 81 was active and had three main features: cables suspended between the east and west ridge tops, a concrete impact pad, and a 600-foot-long sled track (SNL/NM August 1994). The southern aerial cable is 4,800 feet long and can raise items as high as 600 feet (Palmieri May 1992). A smooth-track cable was added to the southern cable Area I in 1977 to accommodate additional trolley simulated aerial flight tests by all three branches of the military service.

A 1983 historical aerial photograph shows that the site had several additional features such as a storage shed, concrete pads, winches, pulleys, cables, and a fire scar caused by a runaway rocket motor to the east of the sled track (SNL/NM August 1994). The sheds, trailers, and camera bunkers in the southern cable area (referred to in other documents as the arena) had been used for equipment storage and were never used for tests. There were no visible signs of spill or contamination in or near these support structures (SNL/NM September 1995). Several of the concrete blocks around the impact pad had been used as anchors for a net that was suspended at the impact pad. The net was later moved to SWMU 63 (SNL/NM September 1995). Three cables and their associated anchors in the southern cable area of SWMU 81 are currently used in test operations: a main cable (constructed in 1970), the trolley cable (constructed in 1977), and a camera cable. Support structures associated with the aerial cables include winches, guide pulleys, and utility trucks (with winches). No hazardous materials were ever stored or noted at the winch sites associated with SWMU 81. There is no evidence that hazardous constituents had ever been used or released at these support structures. No fuel storage areas or fuel spills have been identified (SNL/NM September 1995).

II. Data Quality Objectives

The baseline sampling conducted at SWMU 81A was designed to collect adequate samples to:

- Determine whether hazardous waste or hazardous constituents were ever released at the site
- Characterize the nature and extent of any releases
- Provide sufficient definitive analytical data to support screening risk assessments.

Tables 1 and 2 summarize the sampling design at SWMU 81A. The sources of potential COCs are expended rocket motors and related pieces of scrap metal associated with pull-down tests conducted at the SWMU 81A sled track and associated with former gun firing sites. Table 3 summarizes the analytical methods and data quality requirements necessary (1) to provide adequate characterization of hazardous waste or hazardous constituents associated with expended rocket motors, metal debris, and former gun firing sites and (2) to support risk screening assessments.

All off-site laboratory results were reviewed and verified/validated against "Data Validation Procedure for Chemical and Radiochemical Data," SNL/NM's Environmental Restoration (ER) Project Analytical Operating Procedure 00-03, Rev. 0 (SNL/NM December 1999). All gamma spectroscopy data were reviewed by SNL/NM's Department 7713, Radiation Protection Sample Diagnostic Laboratory to conform with "Laboratory Data Review Guidelines" (SNL/NM July 1996). These reviews confirmed that the data are acceptable for use in the no further action (NFA) proposal for SWMU 81A. The data quality objectives (DQO) for SWMU 81A have been met.

Table 1
Summary of Sampling Performed to Meet Data Quality Objectives

SWMU 81A	Potential COC Source	Area of Site (acres)	Number of Sampling Locations	Sample Density (samples/acre)	Sampling Location Rationale
81A	Expended rocket motors and related scrap metal and former gun firing sites	2.4	28	12	Sample locations based upon a grid along sled track and four judgmental locations around each of the three former gun firing sites.

COC = constituent(s) of concern.
SWMU = Solid Waste Management Unit.

Table 2
Number of Baseline Soil Samples Collected at SWMU 81A[a]

Sample Type	Number of Samples	Radionuclides	Radionuclides	RCRA Metals	VOCs	SVOCs	HE
Baseline	28	28	28	28	28	12	28
Duplicates	1	1	1	1	1	1	1
VOC Trip Blanks	2	–	–	–	2	–	–
Equipment Blanks	1	1	1	1	1	–	1
Total Samples	32	30	30	30	32	13	30
Analytical laboratory	–	GEL	RPSD	GEL	GEL	GEL	GEL

[a]Sampling date: 9/8/98.
GEL = General Engineering Laboratories Inc.
HE = High explosive(s).
RCRA = Resource Conservation and Recovery Act.
RPSD = Radiation Protection Sample Diagnostic Laboratory.
SWMU = Solid Waste Management Unit.
VOC = Volatile organic compound.
SVOC = Semivolatile organic compound.

Table 3
Summary of Data Quality Requirements

Analytical Requirement[a]	Data Quality Level	GEL	Radiation Protection Sample Diagnostics Laboratory Department 7713 SNL/NM
TAL metals EPA Method 6010/7000	Definitive	28 samples 1 duplicate	Not applicable
VOCs EPA Method 8260	Definitive	28 samples 1 duplicate	Not applicable
SVOCs EPA Method 8270	Definitive	12 samples 0 duplicates	Not applicable
HE EPA Method 8330	Definitive	28 samples 1 duplicate	Not applicable
Gross alpha/gross beta EPA Method 900.0	Definitive	28 samples 1 duplicate	Not applicable
Gamma spectroscopy EPA Method 901.1	Definitive	Not applicable	28 samples 1 duplicate

[a]EPA (November 1986).
EPA = U.S. Environmental Protection Agency.
GEL = General Engineering Laboratories.
HE = High explosive(s).
SNL/NM = Sandia National Laboratories/New Mexico.
SVOC = Semivolatile organic compound.
TAL = Target Analyte List.
VOC = Volatile organic compound.

III. Determination of Nature, Rate, and Extent of Contamination

III.1 Introduction

The determination of the nature, rate, and extent of contamination at SWMU 81A was based upon an initial conceptual model validated with baseline sampling at the site. The initial conceptual model was developed from historical background information including site inspections, personal interviews, historical photographs, historical operating records, and radiological and explosives surveys. The DQOs contained in the Work Plan for OU 1333 (SNL/NM September 1995), and the SNL/NM response to the Request for Supplemental Information on the OU 1333 Work Plan (SNL/NM October 1997) identified the sample locations, sample density, sample depth, and analytical requirements. The sampling data were subsequently used to develop the final conceptual model for SWMU 81A that is presented in the SWMU 81A NFA proposal. The quality of the data specifically used to determine the nature, rate, and extent of contamination is described below.

III.2 Nature of Contamination

The nature of contamination at SWMU 81A was determined through analytical testing of the soil media. The analytical testing (for volatile organic compounds, semivolatile organic compounds, high explosives, and metals) was performed to characterize potential releases of COCs. Gamma spectroscopy and gross alpha/gross beta testing were also performed to determine whether any radioactive materials are present at the site. These analytical methods are appropriate for characterizing the COCs and potential degradation products associated with the historical activities at SWMU 81A.

III.3 Rate of Contaminant Migration

Primary sources of COCs were removed from SWMU 81A after testing activities were completed. Some of the debris was buried in SWMU 81C and subsequently removed during a voluntary corrective measure conducted in the fall of 1998. Currently, only very minor amounts of metallic debris remain at the site. The rate of COC migration is dependent predominantly on site meteorological and surface hydrologic processes as described in Section V herein. Data available from the Site-Wide Hydrogeologic Characterization Project (published annually); numerous SNL/NM air, surface-water, and radiological monitoring programs; biological surveys; and other governmental atmospheric monitoring at the Kirtland Air Force Base (i.e., National Oceanographic and Atmospheric Administration) are adequate to characterize the rate of COCs migration at SWMU 81A.

III.4 Extent of Contamination

Twenty-eight soil samples were collected throughout SWMU 81A. The sample collection points were selected based upon an evenly spaced grid on both sides of the sled track, and four samples were collected from each of the three gun firing sites. The number of samples collected (12 samples per acre) was deemed sufficient to establish the presence of detectable COCs related to tests conducted at SWMU 81A.

Because of the relatively low solubility of most metals and organic compounds, limited precipitation, and high evapotranspiration, the vertical rate of contaminant migration is expected to be extremely low. Soil samples were collected from the surface at all sampling locations at SWMU 81A. The sample collection depth was considered representative of the media potentially affected by surface disposal of debris and sufficient to determine the extent of COC migration.

In summary, the design of the baseline sampling was appropriate and adequate to determine the nature, rate, and extent of contamination.

IV. Comparison of COCs to Background Screening Levels

Site history and characterization activities were examined to identify potential COCs. The SWMU 81A NFA proposal describes the identification of COCs and the sampling activities that were conducted in order to determine the concentration levels of those COCs across the site.

Generally, COCs evaluated in this risk assessment included all detected organics and all inorganic and radiological COCs for which samples were analyzed. If the detection limit of an organic compound was too high (i.e., could possibly cause an adverse effect to human health or the environment), then the compound was retained. Nondetect organics not included in this assessment were determined to have sufficiently low detection limits to ensure protection of human health and the environment. In order to provide conservatism in this risk assessment, the calculation used only the maximum concentration value of each COC found for the entire site. The SNL/NM maximum background concentration (Dinwiddie September 1997, Garcia 1998) was selected to provide the background screening listed in Tables 4 and 5. Human health nonradiological COCs were also compared to SNL/NM proposed Subpart S action levels (Table 4) (IT July 1994).

Nonradiological inorganics that are essential nutrients such as iron, magnesium, calcium, potassium, and sodium were not included in this risk assessment (EPA 1989). Both radiological and nonradiological COCs were evaluated. The nonradiological COCs evaluated included both inorganic and organic compounds.

Table 4 lists nonradiological COCs for the human health and ecological risk assessment at SWMU 81A. Table 5 lists radiological COCs for the human health and ecological risk assessment. All tables show the associated SNL/NM maximum background concentration values (Dinwiddie September 1997, Garcia 1998). Sections VI.4, VII.2 and VII.3 discuss Tables 4 and 5.

V. Fate and Transport

The primary releases of COCs at SWMU 81A were to the surface soil. Wind, water, and biota are natural mechanisms of COC transport from the primary release point. Winds at this site, however, are moderated by the canyon topography and by the woodland vegetation. Therefore, wind erosion is probably not significant as a transport mechanism at this site.

Water at SWMU 81A is received as precipitation (rain or occasional snow). Precipitation will either evaporate at or near the point of contact, infiltrate into the soil, or form runoff. Infiltration at the site is enhanced by the coarse nature of the soil (the soil in the area of the site is primarily Tesajo-Millett stony sandy loam [USDA 1977]); however, the sloping terrain of the canyon wall may produce surface runoff during intense rainfall events and during extended rainfall periods when soils are near saturation from previous rainfall. Surface-water runoff from SWMU 81A will flow into the main arroyo channel that drains Sol se Mete Canyon, which in turn discharges into Arroyo del Coyote in Lurance Canyon. Runoff can carry surface soil particles with adsorbed COCs. The distance of transport would depend upon the size of the particle and the velocity of the water. Particles within the drainage can be carried and deposited downstream during periods of surface-water flow.

Water that infiltrates into the soil will continue to percolate through the soil until field capacity is reached. COCs desorbed from the soil particles into the soil solution can be leached into the subsurface soil with this percolation. The effective rooting depths of the soil at SWMU 81A is approximately 60 inches (USDA 1977). This indicates the depth of the system's transient water cycling zone (the dynamic balance between percolation/infiltration and evapotranspiration). Because groundwater at this site is approximately 222 feet bgs and is in a semiconfined or

Table 4
Nonradiological COCs for Human Health and Ecological Risk Assessment at SWMU 81A with Comparison to the Associated SNL/NM Background Screening Value, BCF, Log K_{ow}, and Subpart S Screening Value

COC Name	Maximum Concentration (mg/kg)	SNL/NM Background Concentration (mg/kg)[a]	Is Maximum COC Concentration Less Than or Equal to the Applicable SNL/NM Background Screening Value?	BCF (maximum aquatic)	Log K_{ow} (for organic COCs)	Bioaccumulator?[b] (BCF >40, log K_{ow} >4)	Subpart S Screening Value[c]	Is Individual COC less than 1/10 of the Action Level?
Arsenic	6.73	9.8	Yes	44[d]	NA	**Yes**	0.5	**No**
Barium	234	246	Yes	170[e]	NA	**Yes**	6000	Yes
Beryllium	1.1	0.75	**No**	19[d]	NA	No	0.2	**No**
Cadmium	0.76	0.64	**No**	64[d]	NA	**Yes**	80	Yes
Chromium, total[f]	20.6	18.8	**No**	16[d]	NA	No	400	Yes
Lead	35.5	18.9	**No**	49[d]	NA	**Yes**	–	–
Mercury	0.03	0.055	Yes	5500[d]	NA	**Yes**	20	Yes
Selenium	0.947 J	2.7	Yes	800[g]	NA	**Yes**	400	Yes
Silver	0.304 J	<0.5	**Unknown**	0.5[d]	NA	No	400	Yes
Bromodichloromethane	0.0013	NA	**NA**	1.37[h]	2.10[h]	No	10	Yes
Chloroform	0.0051	NA	**NA**	10.35[h]	1.92[i]	No	100	Yes
Xylene	0.0013 J	NA	**NA**	23.4[h]	1.5[i]	No	200,000	Yes
Diethyl phthalate	0.670	NA	**NA**	117[j]	2.47[j]	**Yes**	60,000	Yes

Note: **Bold** indicates the COCs that failed the background and/or Subpart S screening procedures and/or are bioaccumulators.
[a]From Garcia (1998) Canyon Area Soils.
[b]NMED (March 1998).
[c]IT Corporation (July 1994).
[d]From Yanicak (March 1997).
[e]From Neumann (1976).
[f]Assumed to be chromium VI for Subpart S screening procedure.
[g]From Callahan et al. (1979).
[h]From Howard (1990).
[i]Micromedex, Inc (1998).
[j]From Howard (1989).

BCF = Bioconcentration factor.
COC = Constituent of concern.
J = Estimated concentration.
K_{ow} = Octanol-water partition coefficient.
Log = Logarithm (base 10).
mg/kg = Milligram(s) per kilogram.
NA = Not applicable.
NMED = New Mexico Environment Department.
SNL/NM = Sandia National Laboratories/New Mexico.
SWMU = Solid Waste Management Unit.
– = Information not available.

Table 5
Radiological COCs for Human Health and Ecological Risk Assessment at SWMU 81A with Comparison to the Associated SNL/NM Background Screening Value and BCF

COC Name	Maximum Concentration (pCi/g)	SNL/NM Background Concentration (pCi/g)[a]	Is Maximum COC Concentration Less Than or Equal to the Applicable SNL/NM Background Screening Value?	BCF (maximum aquatic)	Is COC a Bioaccumulator?[c] (BCF >40)
Th-232	**1.15**	1.03	**No**	3000[d]	No[b]
U-238	1.81	2.31	Yes	900[d]	**Yes**
U-235	**0.316**	0.16	**No**	900[d]	**Yes**
U-234	0.23[e]	2.31	Yes	900[d]	**Yes**
Cs-137	0.20	0.515	Yes	3000[f]	**Yes**

Note: **Bold** indicates COCs that exceed background screening values and/or are bioaccumulators.
[a]From Dinwiddie (September 1997), Canyons Area Soils.
[b]From Yanicak (March 1997).
[c]NMED (March 1998).
[d]From Baker and Soldat (1992).
[e]U-234 values were calculated using the U-238 concentration and assuming that the U-238 to U-234 ratio was equal to that detected during waste characterization of DU-contaminated soils generated during the radiological voluntary corrective measures project, where U-234 = U-238/8 (Miller June 1998).
[f]BCF from Whicker and Schultz (1982).

BCF = Bioconcentration factor.
COC = Constituent(s) of concern.
DU = Depleted uranium.
NMED = New Mexico Environment Department.
pCi/g = Picocurie(s) per gram.
SNL/NM = Sandia National Laboratories/New Mexico.
SWMU = Solid Waste Management Unit.

confined aquifer, the potential for COCs to reach groundwater through the unsaturated zone above the watertable is very small. As water from the surface evaporates, the direction of COC movement can be reversed with capillary rise of the soil water.

Plant roots can take up COCs that are in the soil. These COCs can then be transported to the above-ground tissues with the xylem stream. Above-ground tissues can also take up constituents from the air or through direct contact with dust particles. Volatile COCs can be taken up by plants directly from the air; however, volatile COCs can also be lost to the air from the plant tissues. Organic COCs in plant tissues can be metabolized or can undergo other types of biotransformations. Those that remain in the tissue can be consumed by herbivores or eventually be returned to the soil as litter. Above-ground litter can be transported by wind and water until it is decomposed. Constituents in plant tissues that are consumed by herbivores can pass through the gut and be returned to the soil in feces at the site or transported from the site in the herbivore. COCs that are absorbed can be held in tissues, metabolized, or later excreted. The herbivore can be eaten by a primary carnivore or scavenger, and the constituents remaining in the consumed tissues will repeat the sequence of absorption, metabolization, excretion, and eventual consumption by higher predators, scavengers, and decomposers. The potential for transport of the constituents within the food chain depends upon the mobility of the species that comprise the food chain and the potential for the constituent to be transferred across the links in the food chain.

Degradation of COCs at SWMU 81A may result from biotic or abiotic processes. COCs at SWMU 81A that are inorganic and elemental in form are not considered to be degradable. Radiological COCs, however, undergo decay to stable isotopes or radioactive daughter elements. Other transformations of inorganics could include changes in valence (oxidation/reduction reactions) or incorporation into organic forms (e.g., the conversion of selenite or selenate from soil to seleno-amino acids in plants). Degradation processes for organic COCs can include photolysis, hydrolysis, and biotransformation. Photolysis requires light and, therefore, takes place in the air, at the ground surface, or in surface water. Hydrolysis includes chemical transformations in water and can occur in the soil solution. Biotransformation (i.e., transformation through plants, animals, and microorganisms) can occur; however, biological activity may be limited by the aridity of the environment at this site.

Table 6 summarizes the fate and transport processes that can occur at SWMU 81A. COCs at this site include both inorganics (metals and radionuclides) and organics in surface soil. Because of the local topography and woodland vegetation, the potential for transport of COCs by wind is low. The potential for transport by surface-water runoff is moderate for COCs currently at or near the soil surface because of the slopes at the site. Significant leaching of COCs into the subsurface soil is unlikely, and leaching to the groundwater at this site is highly unlikely. For inorganic COCs, the potential for degradation is low and the potential for uptake into the food chain is considered moderate to low because of the terrestrial nature of the habitat and the arid climate. Degradation and/or biotransformation of organics and their loss by volatilization could be significant. The potential for uptake into the food chain by most other organic COCs at SWMU 81A is considered moderate to low because of the terrestrial nature of the habitat and the arid climate. Decay of radiological COCs is insignificant because of their long half lives.

Table 6
Summary of Fate and Transport at SWMU 81A

Transport and Fate Mechanism	Existence at Site	Significance
Wind	Yes	Low
Surface runoff	Yes	Moderate
Migration to groundwater	No	None
Food chain uptake	Yes	Moderate to low
Transformation/degradation	Yes	Moderate to high (organics) Low (inorganics and radionuclides)

SWMU = Solid Waste Management Unit.

VI. Human Health Risk Screening Assessment

VI.1 Introduction

Human health risk screening assessment of this site includes a number of steps that culminate in a quantitative evaluation of the potential adverse human health effects caused by constituents located at the site. The steps discussed herein include the following:

Step 1.	Site data are described that provide information on the potential COCs, as well as the relevant physical characteristics and properties of the site.
Step 2.	Potential pathways are identified by which a representative population might be exposed to the COCs.
Step 3.	The potential intake of these COCs by the representative population is calculated using a tiered approach. The first component of the tiered approach includes two screening procedures. One screening procedure compares the maximum concentration of the COC to an approved SNL/NM maximum background screening value. COCs that are not eliminated during the first screening procedure are subjected to a second screening procedure that compares the maximum concentration of the COC to the SNL/NM proposed Subpart S action level.
Step 4.	Toxicological parameters are identified and referenced for COCs that were not eliminated during the screening steps.
Step 5.	Potential toxicity effects (specified as a hazard index [HI]) and estimated excess cancer risks are calculated for nonradiological COCs and background. For radiological COCs, the incremental total effective dose equivalent (TEDE) and incremental estimated cancer risk are calculated by subtracting applicable background concentrations directly from maximum on-site contaminant values. This background subtraction only occurs when a radiological COC occurs as contamination and exists as a natural background radionuclide.
Step 6.	These values are compared with guidelines established by the EPA and the DOE to determine whether further evaluation, and potential site cleanup, is required. Nonradiological COC risk values are also compared to background risk so that an incremental risk can be calculated.
Step 7.	Uncertainties of the above steps are discussed.

VI.2 Step 1. Site Data

Section I provides the description and history for SWMU 81A. Section II presents the DQOs. Section III describes the determination of the nature, rate, and extent of contamination.

VI.3 Step 2. Pathway Identification

SWMU 81A has been designated a future land use scenario of recreational (DOE et al. October 1995) (see Appendix 1 for default exposure pathways and parameters). Because of the location and the characteristics of the potential contaminants, the primary pathway for human exposure is considered to be soil ingestion for the nonradiological COCs and direct gamma exposure for the radiological COCs. The inhalation pathway for both nonradiological and radiological COCs is included because of the potential exists to inhale dust and volatiles. Soil ingestion is included for the radiological COCs as well. No water pathways to the groundwater are considered. Depth to groundwater at SWMU 81A is in excess of 200 feet bgs. Because of the lack of surface water or other significant mechanisms for dermal contact, the dermal exposure pathway is considered not to be significant. No intake routes through plant, meat, or milk ingestion are considered appropriate for the recreational land use scenario. However, plant uptake is considered for the residential land use scenario.

Pathway Identification

Nonradiological Constituents	Radiological Constituents
Soil ingestion	Soil ingestion
Inhalation (dust and volatiles)	Inhalation (dust)
Plant uptake (residential only)	Plant uptake (residential only)
	Direct gamma

VI.4 Step 3. COC Screening Procedures

Step 3 is discussed in this section and included two screening procedures. The first compares the maximum COC concentration to the background screening level. The second compares maximum COC concentrations to SNL/NM proposed Subpart S action levels. This second procedure is applied only to COCs that are not eliminated during the first screening procedure.

VI.4.1 Background Screening Procedure

VI.4.1.1 Methodology

Maximum concentrations of nonradiological COCs were compared to the approved SNL/NM maximum screening level for this area. The SNL/NM maximum background concentration was selected to provide the background screening (see Table 4) and was used to calculate risk attributable to background (see Table 10). Only the COCs that were above their respective SNL/NM maximum background screening levels or did not have either a quantifiable or calculated background screening level were considered in further risk assessment analyses.

For radiological COCs that exceeded the SNL/NM background screening levels, background values were subtracted from the individual maximum radionuclide concentrations. Those that did not exceed these background levels were not carried any further in the risk assessment. This approach is consistent with DOE Order 5400.5, "Radiation Protection of the Public and the Environment" (DOE 1993). Radiological COCs that did not have a background value and were detected above the analytical minimum detectable activity were carried through the risk assessment at their maximum levels. The resultant radiological COCs remaining after this step are referred to as background-adjusted radiological COCs.

VI.4.1.2 Results

Tables 4 and 5 present SWMU 81A maximum COC concentrations that were compared to the SNL/NM maximum background values (Dinwiddie September 1997, Garcia 1998) for the human health risk assessment. For the nonradiological COCs, four constituents were measured at concentrations greater than their respective background. One nonradiological COC had no quantifiable background concentration, so it is not known whether that COC exceeded background. Four COCs were organic compounds and did not have background-screening levels.

The maximum concentration value for lead is 35.5 milligrams (mg) per kilogram (/kg). The EPA intentionally does not provide any human health toxicological data on lead; therefore, no risk parameter values could be calculated. However, EPA Region 6 guidance for the screening value for lead for the industrial land use scenario is 2,000 mg/kg (EPA 1996); for the residential land use scenario, the EPA screening guidance value is 400 mg/kg (EPA July 1994). The maximum concentration value for lead at this site was less than both screening values; therefore, lead was eliminated from further consideration in the human health risk assessment.

Two radiological COCs (Th-232 and U-235) had maximum measured activity concentrations slightly greater than their respective backgrounds.

VI.4.2 Subpart S Screening Procedure

VI.4.2.1 Methodology

The maximum concentrations of nonradiological COCs not eliminated during the background screening process were compared with action levels (IT July 1994) calculated using methods and equations promulgated in the proposed RCRA Subpart S (EPA 1990) and Risk Assessment Guidance for Superfund (RAGS) (EPA 1989) documentation. Accordingly, all calculations were based upon the assumption that receptor doses from both toxic and potentially carcinogenic compounds result most significantly from ingestion of contaminated soil. Because the samples were all taken from the surface and near surface, this assumption is considered valid. If there were ten or fewer COCs and each had a maximum concentration of less than 1/10 the action level, then the site was judged to pose no significant health hazard to humans. If there were more than ten COCs, then the Subpart S screening procedure was not performed.

VI.4.2.2 Results

Table 4 shows the COCs and the associated proposed Subpart S action levels. The table shows the comparison of the maximum concentration values to 1/10 the proposed Subpart S action level. SNL/NM received guidance in this methodology from the EPA (1996). One COC (beryllium) that failed the background screen revealed concentrations above 1/10 the Subpart S action level. Therefore, all constituents with maximum concentrations above background were carried forward in the risk assessment process, and an individual COC hazard quotient (HQ), a cumulative HI, and an excess cancer risk value were calculated.

Radiological COCs have no predetermined action levels analogous to proposed Subpart S levels; therefore, this step in the screening process was not performed for radiological COCs.

VI.5 Step 4. Identification of Toxicological Parameters

Tables 7 and 8, respectively, list the nonradiological and radiological COCs retained in the risk assessment and the values for the available toxicological information. The toxicological values used for nonradiological COCs listed in Table 7 were taken from the Integrated Risk Information System (IRIS) (EPA 1998a), and the Region 3 (EPA 1997c) and Region 9 (EPA 1996b) electronic databases. Dose conversion factors (DCF) used in determining the excess TEDE values for radiological COCs for the individual pathways were the default values provided in the RESRAD computer code (Yu et al. 1993a) as developed in the following documents:

- DCFs for ingestion and inhalation were taken from "Federal Guidance Report No. 11, Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion" (EPA 1988).

- DCFs for surface contamination (contamination on the surface of the site) were taken from DOE/EH-0070, "External Dose-Rate Conversion Factors for Calculation of Dose to the Public" (DOE 1988).

- DCFs for volume contamination (exposure to contamination deeper than the immediate surface of the site) were calculated using the methods discussed in "Dose-Rate Conversion Factors for External Exposure to Photon Emitters in Soil" (Kocher 1983) and in ANL/EAIS-8, *Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil* (Yu et al. 1993b).

VI.6 Step 5. Exposure Assessment and Risk Characterization

Section VI.6.1 describes the exposure assessment for this risk assessment. Section VI.6.2 provides the risk characterization, including the HI and the excess cancer risk for both the potential nonradiological COCs and associated background for recreational and residential land uses. The incremental TEDE and incremental estimated cancer risk are provided for the background-adjusted radiological COCs for both recreational and residential land uses.

Table 7
Toxicological Parameter Values for SWMU 81A Nonradiological COCs

COC Name	RfD_o (mg/kg-d)	Confidence[a]	RfD_{inh} (mg/kg-d)	Confidence[a]	SF_o (mg/kg-day)$^{-1}$	SF_{inh} (mg/kg-day)$^{-1}$	Cancer Class[b]
Beryllium	2E-3[c]	L to M	5.7E-6[c]	M	–	8.4E+0[c]	B1
Cadmium	5E-4[c]	H	5.7E-5[d]	–	–	6.3E+0[c]	B1
Chromium III	1E+0[c]	L	5.7E-7[e]	–	–	–	–
Chromium VI	5E-3[c]	L	–	–	–	4.2E+1[c]	A
Silver	5E-3[c]	L	–	–	–	–	D
Bromodichloro-methane	2E-2[c]	M	2E-2[d]	–	6.2E-2[c]	6.2E-2[d]	B2
Chloroform	1E-2[c]	M	1E-2[d]	–	6.1E-3[c]	8.1E-2[c]	B2
Xylene	2E+0[c]	M	2E-1[d]	–	–	–	D
Diethyl phthalate	8E-1[c]	L	8E-1[d]	–	–	–	D

[a]Confidence associated with IRIS (EPA 1998a) database values. Confidence: L = low, M = medium, H = high.
[b]EPA weight-of-evidence classification system for carcinogenicity (EPA 1989) taken from IRIS (EPA 1998a) with the exception of 1,2-dibromo-3-chloropropane which was taken from HEAST (EPA 1997a):

B1 = Probable human carcinogen. Limited human data available.
B2 = Probable human carcinogen. Indicates sufficient evidence in animals and inadequate or no evidence in humans.
D = Not classifiable as to human carcinogenicity.

[c]Toxicological parameter values from IRIS electronic database (EPA 1998a).
[d]Toxicological parameter values from EPA Region 9 electronic database (EPA 1996b).
[e]Toxicological parameter values from EPA Region 3 electronic database (EPA 1997c).

COC = Constituent of concern.
EPA = U.S. Environmental Protection Agency.
HEAST = Health Effects Assessment Summary Tables.
IRIS = Integrated Risk Information System.
mg/kg-d = Milligram(s) per kilogram day.
(mg/kg-day)$^{-1}$ = Per milligram per kilogram day.
RfD_{inh} = Inhalation chronic reference dose.
RfD_o = Oral chronic reference dose.
SF_{inh} = Inhalation slope factor.
SF_o = Oral slope factor.
SWMU = Solid Waste Management Unit.
– = Information not available.

Table 8
Radiological Toxicological Parameter Values for SWMU 81A COCs Obtained from RESRAD Risk Coefficients[a]

COC Name	SF_o (1/pCi)	SF_{inh} (1/pCi)	SF_{ev} (g/pCi-yr)	Cancer Class[b]
U-235	4.70E-11	1.30E-08	2.70E-07	A
Th-232	3.30E-11	1.90E-08	2.00E-11	A

[a]From Yu et al. (1993a).
[b]EPA weight-of-evidence classification system for carcinogenicity (EPA 1989): A = Human carcinogen for high dose and high dose rate (i.e., greater than 50 rem per year). For low-level environmental exposures, the carcinogenic effect has not been observed and documented.

COC = Constituent of concern.
EPA = U.S. Environmental Protection Agency.
g/pCi-yr = Gram(s) per picocurie-year.
pCi = Picocurie.
SF_{ev} = External volume exposure slope factor.
SF_{inh} = Inhalation slope factor.
SF_o = Oral (ingestion) slope factor.
SWMU = Solid Waste Management Unit.

VI.6.1 Exposure Assessment

Appendix 1 shows the equations and parameter input values used in calculating intake values and subsequent HI and excess cancer risk values for the individual exposure pathways. The appendix shows parameters for both recreational and residential land use scenarios. The equations for nonradiological COCs are based upon the RAGS (EPA 1989). Parameters are based upon information from the RAGS (EPA 1989) and other EPA guidance documents and reflect the reasonable maximum exposure (RME) approach advocated by the RAGS (EPA 1989). For radiological COCs, the coded equations provided in RESRAD computer code are used to estimate the incremental TEDE and cancer risk for individual exposure pathways. Further discussion of this process is provided in the *Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD* (Yu et al. 1993a).

Although the designated land use scenario is recreational for this site, risk and TEDE values for a residential land use scenario are also presented. These residential risk and TEDE values are presented only to provide perspective of potential risk to human health under the more restrictive land use scenario.

VI.6.2 Risk Characterization

Table 9 shows an HI of 0.00 for the SWMU 81A nonradiological COCs and an estimated excess cancer risk of 4E-9 for the designated recreational land use scenario. The numbers presented included exposure from soil ingestion and dust and volatile inhalation for nonradiological COCs. Table 10 shows an HI of 0.00 and an excess cancer risk of 3E-11

Table 9
Risk Assessment Values for SWMU 81A Nonradiological COCs

COC Name	Maximum Concentration (mg/kg)	Recreational Land Use Scenario[a]		Residential Land Use Scenario[a]	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Beryllium	1.1	0.00	3E-11	0.00	8E-10
Cadmium	0.76	0.00	2E-11	0.62	4E-10
Chromium, total[b]	20.6	0.00	3E-9	0.02	8E-8
Silver	0.304 J	0.00	–	0.01	–
Bromodichloromethane	0.0013	0.00	4E-11	0.00	2E-8
Chloroform	0.0051	0.00	7E-10	0.00	3E-8
Xylene	0.0013 J	0.00	–	0.00	–
Diethyl phthalate	0.670	0.00	–	0.00	–
Total		**0.00**	**4E-9**	**0.7**	**2E-7**

[a]From EPA (1989).
[b]Total chromium assumed to be chromium VI (most conservative).
J = Estimated concentration.
COC = Constituent of concern.
EPA = U.S. Environmental Protection Agency.
mg/kg = Milligram(s) per kilogram.
SWMU = Solid Waste Management Unit.
– = Information not available.

Table 10
Risk Assessment Values for SWMU 81A Nonradiological Background Constituents

COC Name	Background Concentration[a] (mg/kg)	Recreational Land Use Scenario[b]		Residential Land Use Scenario[b]	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Beryllium	0.75	0.00	2E-11	0.00	6E-10
Cadmium	0.64	0.00	1E-11	0.52	4E-10
Chromium, total[c]	18.8	0.00	–	0.01	–
Silver	<0.5	–	–	–	–
Total		**0.00**	**3E-11**	**0.5**	**1E-9**

[a]From Garcia (1998), Canyons Area.
[b]From EPA (1989).
[c]Total chromium assumed to be chromium III (most conservative).
COC = Constituent of concern.
EPA = U.S. Environmental Protection Agency.
mg/kg = Milligram(s) per kilogram.
SWMU = Solid Waste Management Unit.
– = Information not available.

assuming the maximum background concentrations of the SWMU 81A associated background constituents for the designated recreational land use scenario.

For the radiological COCs, contribution from the direct gamma exposure pathway is included. For the recreational land use scenario, a TEDE was calculated for an individual who spends 4 hours per week on the site. This resulted in an incremental TEDE of 4.4E-2 millirem (mrem) per year (/yr). In accordance with EPA guidance found in Office of Solid Waste and Emergency Response Directive No. 9200.4-18 (EPA 1997b), an incremental TEDE of 15 mrem/yr is used for the probable land use scenario (recreational in this case); the calculated dose value for SWMU 81A for the recreational land use is well below this guideline. The estimated excess cancer risk is 7.5E-7.

For the residential land use scenario nonradioactive COCs, the HI is 0.7, and the excess cancer risk is 1E-7 (Table 9). The numbers in the table included exposure from soil ingestion, dust and volatile inhalation, and plant uptake. Although the EPA (1991) generally recommends that inhalation not be included in a residential land use scenario, this pathway is included because of the potential for soil in Albuquerque, New Mexico, to be eroded and, subsequently, for dust to be present in predominantly residential areas. Because of the nature of the local soil, other exposure pathways are not considered (see Appendix 1). Table 10 shows that for the SWMU 81A associated background constituents, the HI is 0.5 and the excess cancer risk is 1E-9.

For the radiological COCs, the incremental TEDE for the residential land use scenario is 6.9E-1 mrem/yr. The guideline being used is an excess TEDE of 75 mrem/yr (SNL/NM February 1998) for a complete loss of institutional controls (residential land use in this case); the calculated dose value for SWMU 81A for the residential land use scenario is well below this guideline. Consequently, SWMU 81A is eligible for unrestricted radiological release as the residential land use scenario resulted in an incremental TEDE of less than 75 mrem/yr to the on-site receptor. The estimated excess cancer risk is 8.7E-6. The excess cancer risk from the nonradiological COCs and the radiological COCs is not additive, as noted in the RAGS (EPA 1989).

VI.7 Step 6. Comparison of Risk Values to Numerical Guidelines.

The human health risk assessment analysis evaluated the potential for adverse health effects for both the recreational land use scenario (the designated land use scenario for this site) and the residential land use scenario.

For the recreational land use scenario nonradiological COCs, the HI is 0.00 (less than the numerical guideline of 1 suggested in the RAGS [EPA 1989]). Excess cancer risk is estimated at 4E-9. Guidance from the NMED indicates that excess lifetime risk of developing cancer by an individual must be less than 1E-6 for Class A and B carcinogens and less than 1E-5 for Class C carcinogens (NMED March 1998). The excess cancer risk at this site is driven by chromium, total. Total chromium is conservatively assumed to be chromium VI. Chromium VI is a Class A carcinogen. Thus, the excess cancer risk for this site is below the suggested acceptable risk value (1E-6). This assessment also determined risks considering background concentrations of the potential nonradiological COCs for both the recreational and residential land use scenarios. Assuming the recreational land use scenario, for nonradiological COCs the

HI is 0.00 and the excess cancer risk is 3E-11. Incremental risk is determined by subtracting risk associated with background from potential COC risk. These numbers are not rounded before the difference is determined and, therefore, may appear to be inconsistent with numbers presented in tables and within the text. For conservatism, the background constituent that does not have a quantified background concentration (silver) is assumed to have an HQ of 0.00. Incremental HI is 0.00 and estimated incremental cancer risk is 3.76E-9 for the recreational land use scenario. These incremental risk calculations indicated insignificant risk to human health from nonradiological COCs considering the recreational land use scenario.

For radiological COCs of the recreational land use scenario, incremental TEDE is 4.4E-2 mrem/yr, which is significantly less than the EPA's numerical guideline of 15 mrem/yr. Incremental estimated excess cancer risk is 7.5E-7.

The calculated HI for the residential land use scenario nonradiological COCs is 0.7, which is below the numerical guidance. Excess cancer risk is estimated at 1E-7. The excess cancer risk is driven by total chromium and three organics. Total chromium is conservatively assumed to be chromium VI. Chromium VI is a Class A carcinogen; all three organics are Class B2 carcinogens. Therefore, the excess cancer risk for this site is below the suggested acceptable risk value (1E-6). The HI for associated background for the residential land use scenario is 0.5; the excess cancer risk is estimated at 1E-9. The incremental HI is 0.12 and the estimated incremental cancer risk is 1.30E-7 for the residential land use scenario. These incremental risk calculations indicate insignificant contribution to human health risk from the COCs considering the residential land use scenario.

The incremental TEDE for a residential land use scenario from the radiological components is 6.9E-1 mrem/yr, which is significantly less than the numerical guideline of 75 mrem/yr suggested in the SNL/NM RESRAD Input Parameter Assumptions and Justification (SNL/NM February 1998). The estimated excess cancer risk is 8.7E-6.

VI.8 Step 7. Uncertainty Discussion

The determination of the nature, rate, and extent of contamination at SWMU 81A was based upon an initial conceptual model validated with baseline sampling conducted at the site. The baseline sampling was implemented in accordance with the RFI work plan for OU 1333 (SNL/NM September 1995) and the SNL/NM response to the Request for Supplemental Information on the OU 1333 Work Plan (SNL/NM October 1997). The DQOs contained in the RFI work plan are appropriate for use in screening risk assessments. The data collected based upon sample location, density, and depth were representative of the site. The analytical requirements and results satisfy the DQOs. Data quality was validated in accordance with SNL/NM procedures (SNL/NM December 1999). Therefore, there is no uncertainty associated with the data quality used to perform the screening risk assessment at SWMU 81A.

Because of the location, history of the site, and future land use (DOE et al. October 1995), there is low uncertainty in the land use scenario and the potentially affected populations that were considered in performing the risk assessment analysis. Because the COCs were found in surface and near-surface soils and because of the location and physical characteristics of the site, there is little uncertainty in the exposure pathways relevant to the analysis.

An RME approach was used to calculate the risk assessment values. This means that the parameter values in the calculations are conservative and that calculated intakes are probably overestimates. Maximum measured values of COC concentrations are used to provide conservative results.

Table 7 shows the uncertainties (confidence) in nonradiological toxicological parameter values. There is a mixture of estimated values and values from the IRIS (EPA 1998a), the HEAST (EPA 1997a), EPA Region 3 (EPA 1997c) and EPA Region 9 (EPA 1996b) electronic databases. Where values are not provided, information is not available from the HEAST (EPA 1997a), IRIS (EPA 1998a), or the EPA regions (EPA 1996b, 1997c). Because of the conservative nature of the RME approach, uncertainties in toxicological values are not expected to change the conclusion from the risk assessment analysis.

Risk assessment values for nonradiological COCs are within the human health acceptable range for the recreational land use scenario compared to established numerical guidance.

For radiological COCs, the conclusion of the risk assessment is that potential effects on human health for both recreational and residential land use scenarios are within guidelines and are a small fraction of the estimated 360 mrem/yr received by the average U.S. population (NCRP 1987).

The overall uncertainty in all of the steps in the risk assessment process is considered not significant with respect to the conclusion reached.

VI.9 Summary

SWMU 81A has identified COCs consisting of some inorganic, organic, and radiological compounds. Because of the location of the site, the designated recreational land use scenario, and the nature of contamination, potential exposure pathways identified for this site included soil ingestion and dust and volatile inhalation for chemical constituents and soil ingestion, dust inhalation, and direct gamma exposure for radionuclides. Plant uptake was included as an exposure pathway for the residential land use scenario.

Using conservative assumptions and an RME approach to risk assessment, calculations for nonradiological COCs show that for the recreational land use scenario the HI (0.00) is significantly less than the accepted numerical guidance from the EPA. Excess cancer risk (4E-9) is also below the acceptable risk value provided by the NMED for a recreational land use scenario (NMED March 1998). The incremental HI is 0.00, and the incremental cancer risk is 3.76E-9 for the recreational land use scenario. Incremental risk calculations indicated insignificant risk to human health for the recreational land use scenario.

Incremental TEDE and corresponding estimated cancer risk from radiological COCs are much less than EPA guidance values; the estimated TEDE is 4.4E-2 mrem/yr for the recreational land use scenario. This value is much less than the numerical guidance of 15 mrem/yr in EPA guidance (EPA 1997b). The corresponding incremental estimated cancer risk value is 7.5E-7 for the recreational land use scenario. Furthermore, the incremental TEDE for the residential land use scenario that results from a complete loss of institutional control is only 6.9E-1 mrem/yr with an associated risk of 8.7E-6. The guideline for this scenario is 75 mrem/yr

(SNL/NM February 1998). Therefore, SWMU 81A is eligible for unrestricted radiological release.

Uncertainties associated with the calculations are considered small relative to the conservativeness of risk assessment analysis. It is, therefore, concluded that this site poses insignificant risk to human health under the recreational land use scenario.

VII. Ecological Risk Screening Assessment

VII.1 Introduction

This section addresses the ecological risks associated with exposure to constituents of potential ecological concern (COPEC) in soils at SWMU 81A. A component of the NMED's Risk-Based Decision Tree (March 1998) is to conduct an ecological screening assessment that corresponds with that presented in the EPA's Ecological Risk Assessment Guidance for Superfund (EPA 1997d). The current methodology is tiered and contains an initial scoping assessment followed by a more detailed screening assessment. Initial components of the NMED's decision tree (a discussion of DQOs, a data assessment, and evaluations of bioaccumulation and fate and transport potential) are addressed in previous sections of this report. Following the completion of the scoping assessment, a determination is made as to whether a more detailed examination of potential ecological risk is necessary. If deemed necessary, the scoping assessment proceeds to a screening assessment whereby a more quantitative estimate of ecological risk is conducted. Although this assessment incorporates conservatisms in the estimation of ecological risks, ecological relevance and professional judgment are also used as recommended by the EPA (1998b) to ensure that predicted exposures of selected ecological receptors reflect those reasonably expected to occur at the site.

VII.2 Scoping Assessment

The scoping assessment focuses primarily on the likelihood of exposure of biota at/or adjacent to the site to be exposed to constituents associated with site activities. Included in this section are an evaluation of existing data and a comparison of maximum detected concentrations to background concentrations, examination of bioaccumulation potential, and fate and transport potential. A scoping risk management decision (Section VII.2.4) involves summarizing the scoping results and determining whether further examination of potential ecological impacts is necessary.

VII.2.1 Data Assessment

As indicated in Section IV (refer to Tables 3 and 4), inorganic constituents in soil within the 0- to 5-foot depth interval that exceeded background concentrations were as follows:

- Beryllium
- Cadmium

- Chromium (total)
- Lead
- Th-232
- U-235.

One constituent (silver) does not have a quantified background screening concentration. Thus, it is unknown if the reported silver concentration exceeds background.

Organic analytes detected in soil were as follows:

- Bromodichloromethane
- Chloroform
- Diethyl phthalate
- Xylenes.

VII.2.2 Bioaccumulation

Among the COPECs listed in Section VII.2.1, the following were considered to have bioaccumulation potential in aquatic environments (Section IV, Tables 3 and 4):

- Cadmium
- Lead
- U-235
- Diethyl phthalate.

It should be noted, however, that as directed by the NMED (March 1998), bioaccumulation for inorganics is assessed exclusively based upon maximum reported bioconcentration factors (BCF) for aquatic species. Because only aquatic BCFs are used to evaluate the bioaccumulation potential for metals, bioaccumulation in terrestrial species is likely to be overpredicted.

VII.2.3 Fate and Transport Potential

The potential for the COPECs to move from the source of contamination to other media or biota is discussed in Section V. As noted in Table 6 (refer to Section V), wind is expected to be of low significance as a transport mechanism for COPECs at this site, but surface-water runoff may be of moderate significance. Migration to groundwater is not anticipated. Food chain uptake is expected to be of moderate to low significance. Degradation/transformation for inorganic COPECs and radionuclides is expected to be of low significance. For the organic COPECs, the potential for biotransformation/ degradation is moderate to high, and loss by volatilization is also expected to occur.

VII.2.4 Scoping Risk Management Decision

Based upon information gathered through the scoping assessment, it was concluded that complete ecological pathways may be associated with this SWMU and that COPECs also exist at the site. As a consequence, a screening assessment was deemed necessary to predict the potential level of ecological risk associated with the site.

VII.3 Screening Assessment

As concluded in Section VII.2.4, complete ecological pathways and COPECs are associated with this SWMU. The screening assessment performed for the site involves a quantitative estimate of current ecological risks using exposure models in association with exposure parameters and toxicity information obtained from the literature. The estimation of potential ecological risks is conservative to ensure that ecological risks are not underpredicted.

Components within the screening assessment include the following:

- Problem Formulation—sets the stage for the evaluation of potential exposure and risk.
- Exposure Estimation—provides a quantitative estimate of potential exposure.
- Ecological Effects Evaluation—presents benchmarks used to gauge the toxicity of COPECs to specific receptors.
- Risk Characterization—characterizes the ecological risk associated with exposure of the receptors to environmental media at the site.
- Uncertainty Assessment—discusses uncertainties associated with the estimation of exposure and risk.
- Risk Interpretation—evaluates ecological risk in terms of HQs and ecological significance.
- Screening Assessment Scientific/Management Decision Point—presents the decision to risk managers based upon the results of the screening assessment.

VII.3.1 Problem Formulation

Problem formulation is the initial stage of the screening assessment that provides the introduction to the risk evaluation process. Components that are addressed in this section include a discussion of ecological pathways and the ecological setting, identification of COPECs, and selection of ecological receptors. The conceptual model, ecological food webs, and ecological endpoints (other components commonly addressed in a screening assessment) are presented in the "Predictive Ecological Risk Assessment Methodology" for the SNL/NM ER Program" (IT July 1998) and are not duplicated here.

VII.3.1.1 Ecological Pathways and Setting

SWMU 81A is approximately 2.4 acres in size. The site, located in Sol se Mete Canyon, is dominated by woodland habitat; however, much of the habitat at this site was disturbed during active use. Wildlife may use the area, but the small size and long, narrow shape of the site make significant exposures in most wildlife species unlikely. A biological and sensitive species survey of the entire Aerial Cable Facility was conducted in 1991 (Sullivan 1994), and in 1993 and 1994 the area was included in a basewide threatened and endangered species survey conducted by the New Mexico Natural Heritage Program for the USAF (NMNHP 1995). Although the gray vireo (*Vireo vicinior*), a New Mexico threatened species, was observed in the upper part of Sol se Mete Canyon in 1991 (probably a migrating individual) and three singing males were observed in Lurance Canyon near the mouth of Sol se Mete Canyon during the New Mexico Natural Heritage Program surveys, the species is not known to occur at SWMU 81A.

Complete ecological pathways may exist at this site through the exposure of plants and wildlife to COPECs in surface soil. It was assumed that direct uptake of COPECs from soil was the major route of exposure for plants and that exposure of plants to wind-blown soil was minor. Exposure modeling for the wildlife receptors was limited to the food and soil ingestion pathways and external radiation. Because of the lack of surface water at this site, exposure to COPECs through the ingestion of surface water was considered insignificant. Inhalation and dermal contact were also considered insignificant pathways with respect to ingestion (Sample and Suter 1994). Groundwater is not expected to be affected by COCs at this site.

VII.3.1.2 COPECs

Inorganic and organic COPECs for SWMU 81A are listed in Section VII.2.1. The inorganic COPECs included both radiological and nonradiological analytes. The inorganic analytes were screened against background concentrations, and those that exceeded the approved SNL/NM background screening levels (Dinwiddie September 1997) for the area were considered to be COPECs. All organic analytes detected were considered to be COPECs for the site. In order to provide conservatism, this ecological risk assessment was based upon the maximum soil concentrations of the COPECs measured in the surface soil at this site. Tables 3 and 4 present maximum concentrations for the COPECs. Nonradiological inorganics that are essential nutrients, such as iron, magnesium, calcium, potassium, and sodium, were not included in this risk assessment as set forth by the EPA (1989).

VII.3.1.3 Ecological Receptors

As described in detail in an IT Corporation report (July 1998), a nonspecific perennial plant was selected as the receptor to represent plant species at the site. Vascular plants are the principal primary producers at the site and are key to the diversity and productivity of the wildlife community associated with the site. The deer mouse (*Peromyscus maniculatus*) and the burrowing owl (*Speotyto cunicularia*) were used to represent wildlife use. Because of its opportunistic food habits, the deer mouse was selected to represent a mammalian herbivore, omnivore, and insectivore. The burrowing owl was selected to represent a top predator at this site. Although burrowing owls are not expected to occur in the woodland habitat at SWMU 81A, it is used to provide conservative representation of exposure and risk to other small, predatory birds such as the western screech owl (*Otus kennicottii*) that may inhabit this site. The burrowing owl is present at SNL/NM and is designated a species of management concern by the U.S. Fish and Wildlife Service in Region 2, which includes the state of New Mexico (USFWS September 1995).

VII.3.2 Exposure Estimation

For nonradiological COPECs, direct uptake from the soil was considered the only significant route of exposure for terrestrial plants. Exposure modeling for the wildlife receptors was limited to food and soil ingestion pathways. Inhalation and dermal contact were considered insignificant pathways with respect to ingestion (Sample and Suter 1994). Drinking water was also considered an insignificant pathway because of the lack of surface water at this site. The deer mouse was modeled under three dietary regimes: as an herbivore (100 percent of its diet as plant material), as an omnivore (50 percent of its diet as plants and 50 percent as soil invertebrates), and as an insectivore (100 percent of its diet as soil invertebrates). The burrowing owl was modeled as a strict predator on small mammals (100 percent of its diet as deer mice). Because the exposure in the burrowing owl from a diet consisting of equal parts of herbivorous, omnivorous, and insectivorous mice would be equivalent to the exposure consisting of only omnivorous mice, the diet of the burrowing owl was modeled with intake of omnivorous mice only. Both species were modeled with soil ingestion comprising 2 percent of the total dietary intake. Table 11 presents the species-specific factors used in modeling exposures in the wildlife receptors. Justification for use of the factors presented in this table is described in the ecological risk assessment methodology document (IT July 1998).

Although home range is also included in this table, exposures for this risk assessment were modeled using an area use factor of 1, implying that all food items and soil ingested are from the site being investigated. The maximum measured COPEC concentrations from surface soil samples were used to provide a conservative estimate of potential exposures and risks to plants and wildlife at this site.

For the radiological dose rate calculations, the deer mouse was modeled as an herbivore (100 percent of its diet as plants), and the burrowing owl was modeled as a strict predator on small mammals (100 percent of its diet as deer mice). Both were modeled with soil ingestion comprising 2 percent of the total dietary intake. Receptors are exposed to radiation both internally and externally from Th-232 and U-235. Internal and external dose rates to the deer mouse and the burrowing owl are approximated using modified dose rate models from the DOE (1995), as presented in the ecological risk assessment methodology document for the SNL/NM ER Project (IT July 1998). Radionuclide-dependent data for the dose rate calculations were obtained from Baker and Soldat (1992). The external dose rate model examines the total-body dose rate to a receptor residing in soil exposed to radionuclides. The soil surrounding the receptor is assumed to be an infinite medium uniformly contaminated with gamma-emitting radionuclides. The external dose rate model is the same for both the deer mouse and the burrowing owl. The internal total-body dose rate model assumes that a fraction of the radionuclide concentration ingested by a receptor is absorbed by the body and concentrated at the center of a spherical body shape. This provides for a conservative estimate for absorbed dose. This concentrated radiation source at the center of the body of the receptor is assumed to be a "point" source. Radiation emitted from this point source is absorbed by the body tissues

Table 11
Exposure Factors for Ecological Receptors at SWMU 81A

Receptor Species	Class/Order	Trophic Level	Body Weight (kg)[a]	Food Intake Rate (kg/day)[b]	Dietary Composition[c]	Home Range (acres)
Deer mouse (*Peromyscus maniculatus*)	Mammalia/ Rodentia	Herbivore	2.39E-2[d]	3.72E-3	Plants: 100% (+ soil at 2% of intake)	2.7E-1[e]
Deer mouse (*Peromyscus maniculatus*)	Mammalia/ Rodentia	Omnivore	2.39E-2[d]	3.72E-3	Plants: 50% Invertebrates: 50% (+ soil at 2% of intake)	2.7E-1[e]
Deer mouse (*Peromyscus maniculatus*)	Mammalia/ Rodentia	Insectivore	2.39E-2[d]	3.72E-3	Invertebrates: 100% (+ soil at 2% of intake)	2.7E-1[e]
Burrowing owl (*Speotyto cunicularia*)	Aves/ Strigiformes	Carnivore	1.55E-1[f]	1.73E-2	Rodents: 100% (+ soil at 2% of intake)	3.5E+1[g]

[a]Body weights are in kg wet weight.
[b]Food intake rates are estimated from the allometric equations presented in Nagy (1987). Units are kg dry weight per day.
[c]Dietary compositions are generalized for modeling purposes. Default soil intake value of 2% of food intake.
[d]From Silva and Downing (1995).
[e]EPA (1993), based upon the average home range measured in semiarid shrubland in Idaho.
[f]From Dunning (1993).
[g]From Haug et al. (1993).
EPA = U.S. Environmental Protection Agency.
kg = Kilogram(s).
kg/day = Kilogram(s) per day.
SWMU = Solid Waste Management Unit.

to contribute to the absorbed dose. Alpha and beta emitters are assumed to transfer 100 percent of their energy to the receptor as they pass through tissues. Gamma-emitting radionuclides only transfer a fraction of their energy to the tissues because gamma rays interact less with matter than do beta or alpha emitters. The external and internal dose rate results are summed to calculate a total dose rate from exposure to Th-232 and U-235 in soil.

Table 12 presents the transfer factors used in modeling the concentrations of COPECs through the food chain. Table 13 presents maximum concentrations in soil and derived concentrations in tissues of the various food chain elements that are used to model dietary exposures for each of the wildlife receptors.

VII.3.3 Ecological Effects Evaluation

Table 14 shows benchmark toxicity values for the plant and wildlife receptors. For plants the benchmark soil concentrations are based upon the lowest-observed-adverse-effect level (LOAEL). For wildlife the toxicity benchmarks are based upon the no-observed-adverse-effect level (NOAEL) for chronic oral exposure in a taxonomically similar test species. Insufficient toxicity information was found to estimate the LOAELs or NOAELs for some COPECs for terrestrial plant life and for the burrowing owl, respectively.

The benchmark used for exposure of terrestrial receptors to radiation was 0.1 rad/day. This value has been recommended by the International Atomic Energy Agency (IAEA 1992) for the protection of terrestrial populations. Because plants and insects are less sensitive to radiation than vertebrates (Whicker and Schultz 1982), the dose of 0.1 rad/day should also offer sufficient protection to other components within the terrestrial habitat of SWMU 81A.

VII.3.4 Risk Characterization

Maximum concentrations in soil and estimated dietary exposures were compared to plant and wildlife benchmark values, respectively. Table 15 presents results of these comparisons. HQs are used to quantify the comparison with benchmarks for plants and wildlife exposure.

Chromium (total) exposure in plants was the exposure pathway that resulted in an HQ exceeding unity. HQs could not be determined for any of the organic COPECs for plants and the burrowing owl. HQs for the burrowing owl could not be determined for beryllium and silver. As directed by the NMED, HIs were calculated for each of the receptors (the HI is the sum of chemical-specific HQs for all pathways for a given receptor). Only plants had a total HI greater than unity (HI = 22).

Tables 16 and 17 summarize the internal and external dose rate model results for Th-232 and U-235. The total radiation dose rate to both the deer mouse and the burrowing owl was predicted to be 2.3E-4 rad/day. The dose rates for the deer mouse and the burrowing owl are considerably less than the benchmark of 0.1 rad/day.

Table 12
Transfer Factors Used in Exposure Models for Constituents of Potential Ecological Concern at SWMU 81A

Constituent of Potential Ecological Concern	Soil-to-Plant Transfer Factor	Soil-to-Invertebrate Transfer Factor	Food-to-Muscle Transfer Factor
Inorganic			
Beryllium	1.0E-2[a]	1.0E+0[b]	1.0E-3[a]
Cadmium	5.5E-1[a]	6.0E-1[c]	5.5E-4[a]
Chromium (total)	4.0E-2[d]	1.3E-1[e]	3.0E-2[d]
Lead	9.0E-2[d]	4.0E-2[c]	8.0E-4[d]
Silver	1.0E+0[d]	2.5E-1[c]	5.0E-3[d]
Organic[f]			
Bromodichloromethane	1.1E+1	1.5E+1	1.6E-7
Chloroform	3.0E+0	1.6E+1	1.8E-6
Diethyl phthalate	1.5E+0	1.8E+1	6.6E-6
Xylenes	5.5E-1	1.9E+1	3.7E-5

[a]From Baes et al. (1984).
[b]Default value.
[c]From Stafford et al. (1991).
[d]From NCRP (January 1989).
[e]From IAEA (1994).
[f]Soil-to-plant and food-to-muscle transfer factors from equations developed in Travis and Arms (1988). Soil-to-invertebrate transfer factors from equations developed in Connell and Markwell (1990). All three equations based upon relationship of the transfer factor to the log K_{ow} value of compound.
IAEA = International Atomic Energy Agency.
K_{ow} = Octanol-water partition coefficient.
Log = Logarithm (base 10).
NCRP = National Council on Radiation Protection and Measurements.
SWMU = Solid Waste Management Unit.

Table 13
Media Concentrations[a] for Constituents of Potential Ecological Concern at SWMU 81A

Constituent of Potential Ecological Concern	Soil (maximum)[a]	Plant Foliage[b]	Soil Invertebrate[b]	Deer Mouse Tissues[c]
Inorganic				
Beryllium	1.1E+0	1.1E-2	1.1E+0	1.8E-3
Cadmium	7.6E-1	4.2E-1	4.6E-1	7.8E-4
Chromium (total)	2.1E+1	8.2E-1	2.7E+0	2.0E-1
Lead	3.6E+1	3.2E+0	1.4E+0	7.5E-3
Silver	3.0E-1[d]	3.0E-1	7.6E-2	3.1E-3
Organic				
Bromodichloromethane	1.3E-3	1.5E-2	1.9E-2	8.7E-9
Chloroform	5.1E-3	1.5E-2	8.4E-2	2.8E-7
Diethyl phthalate	6.7E-1	9.7E-1	1.2E+1	1.3E-4
Xylenes	1.3E-3[d]	7.1E-4	2.5E-2	1.5E-6

[a]In mg/kg. All biotic media are based upon dry weight of the media. Soil concentration measurements are assumed to have been based upon dry weight. Values have been rounded to two significant digits after calculation.
[b]Product of the soil concentration and the corresponding transfer factor.
[c]Based upon the deer mouse with an omnivorous diet. Product of the average concentration ingested in food and soil times the food-to-muscle transfer factor times a wet weight-dry weight conversion factor of 3.125 (EPA 1993).
[d]Based upon an estimated concentration.
mg/kg = Milligram(s) per kilogram.
SWMU = Solid Waste Management Unit.

Table 14
Toxicity Benchmarks for Ecological Receptors at SWMU 81A

Constituent of Potential Ecological Concern	Plant Benchmark[a,b]	Mammalian NOAELs			Avian NOAELs		
		Mammalian Test Species[c,d]	Test Species NOAEL[d,e]	Deer Mouse NOAEL[e,f]	Avian Test Species[d]	Test Species NOAEL[d,e]	Burrowing Owl NOAEL[e,g]
Inorganic							
Beryllium	10	Rat	0.66	1.29	–	–	–
Cadmium	3	Rat[h]	1.0	1.9	Mallard	1.45	1.45
Chromium (total)	1	Rat	2,737	5,354	Black duck	1.0	1.0
Lead	50	Rat	8.0	15.7	American kestrel	3.85	3.85
Silver	2	Rat	17.8[i]	34.8	–	–	–
Organic							
Bromodichloromethane	–	Rat	7.10[j]	13.9	–	–	–
Chloroform	–	Rat	15	29.3	–	–	–
Diethyl phthalate	–	Mouse	75.3[k]	79.7	–	–	–
Xylenes	–	Mouse	2.1	2.22	–	–	–

[a]In mg/kg soil dry weight.
[b]From Efroymson et al. (1997).
[c]Body weights (in kg) for the NOAEL conversion are as follows: lab mouse, 0.030; lab rat, 0.350 (except where noted).
[d]From Sample et al. (1996), except where noted.
[e]In mg/kg body weight/day.
[f]Based upon NOAEL conversion methodology presented in Sample et al. (1996), using a deer mouse body weight of 0.0239 kg and a mammalian scaling factor of 0.25.
[g]Based upon NOAEL conversion methodology presented in Sample et al. (1996). The avian scaling factor of 0.0 was used, making the NOAEL independent of body weight.
[h]Body weight: 0.303 kg.
[i]Based upon a rat LOAEL of 89 mg/kg/d (EPA 1998a) and an uncertainty factor of 0.2.
[j]Based upon the rat NOAEL for chloroform and the ratio of LD_{50} values for bromodichloromethane and chloroform (Micromedex 1998).
[k]Based upon a mouse NOAEL for bis(2-ethylhexyl)phthalate and the ratio of LD_{50} values for bis(2-ethylhexyl)phthalate and diethyl phthalate (Micromedex 1998).

d = Day.
EPA = U.S. Environmental Protection Agency.
kg = Kilogram(s).
LD_{50} = Acute lethal dose to 50 percent of the test population.
LOAEL = Lowest-observed-adverse-effect level.
mg = Milligram(s).
NOAEL = No-observed-adverse-effect level.
SWMU = Solid Waste Management Unit.
– = Insufficient toxicity data.

Table 15
HQs for Ecological Receptors at SWMU 81A

Constituent of Potential Ecological Concern	Plant HQ	Deer Mouse HQ (Herbivorous)	Deer Mouse HQ (Omnivorous)	Deer Mouse HQ (Insectivorous)	Burrowing Owl HQ
Inorganic					
Beryllium	1.1E-1	4.0E-3	7.0E-2	1.4E-1	–
Cadmium	2.5E-1	3.6E-2	3.7E-2	3.9E-2	1.2E-3
Chromium (total)	**2.1E+1**	3.6E-5	6.3E-5	9.0E-5	6.9E-2
Lead	7.1E-1	3.9E-2	3.0E-2	2.1E-2	2.1E-2
Silver	1.5E-1	1.4E-3	8.8E-4	3.7E-4	–
Organic					
Bromodichloromethane	–	1.7E-4	1.9E-4	2.1E-4	–
Chloroform	–	8.2E-5	2.6E-4	4.4E-4	–
Diethyl phthalate	–	1.9E-3	1.2E-2	2.3E-2	–
Xylenes	–	5.2E-5	8.9E-4	1.7E-3	–
HI[b]	**2.2E+1**	8.3E-2	1.5E-1	2.3E-1	9.1E-2

Note: **Bold** values indicate HQ or HI exceeds unity.
[a]The HI is the sum of individual HQs using the value for organic mercury as a conservative estimate of the HI.
HI = Hazard index.
HQ = Hazard quotient.
SWMU = Solid Waste Management Unit.
– = Insufficient toxicity data available for risk estimation purposes.

Table 16
Internal and External Dose Rates for the Deer Mouse Exposed to Radionuclides at SWMU 81A

Radionuclide	Maximum Concentration (pCi/g)	Internal Dose (rad/day)	External Dose (rad/day)	Total Dose (rad/day)
Th-232	1.15	4.59E-07	2.17E-04	2.18E-04
U-235	0.316	3.43E-06	5.15E-06	8.58E-06
Total		3.89E-06	2.23E-04	2.26E-04

pCi/g = Picocurie(s) per gram.
SWMU = Solid Waste Management Unit.

Table 17
Internal and External Dose Rates for the Burrowing Owl Exposed to Radionuclides at SWMU 81A

Radionuclide	Maximum Concentration (pCi/g)	Internal Dose (rad/day)	External Dose (rad/day)	Total Dose (rad/day)
Th-232	1.15	6.73E-07	2.17E-04	2.18E-04
U-235	0.316	1.38E-06	5.15E-06	6.53E-06
Total		2.05E-06	2.23E-04	2.25E-04

pCi/g = Picocurie(s) per gram.
SWMU = Solid Waste Management Unit.

Table 18
HQs for Ecological Receptors Exposed to Background Concentrations at SWMU 81A

Constituent of Potential Ecological Concern	Plant HQ	Deer Mouse HQ (Herbivorous)	Deer Mouse HQ (Omnivorous)	Deer Mouse HQ (Insectivorous)	Burrowing Owl HQ
Inorganic					
Beryllium	7.5E-2	2.7E-3	4.8E-2	9.2E-2	–
Cadmium	2.1E-1	3.0E-2	3.1E-2	3.3E-2	1.0E-3
Chromium (total)	**1.9E+1**	3.3E-5	5.7E-5	8.2E-5	6.3E-2
Lead	3.8E-1	2.1E-2	1.6E-2	1.1E-2	1.1E-2
Silver	1.3E-1	1.1E-3	7.2E-4	3.0E-4	–
HI[a]	**2.0E+1**	5.6E-2	9.6E-2	1.4E-1	7.5E-2

Note: **Bold** values indicate HQ or HI exceeds unity.
[a]The HI is the sum of individual HQs using the value for organic mercury as a conservative estimate of the HI.
HI = Hazard index.
HQ = Hazard quotients.
SWMU = Solid Waste Management Unit.
– = Insufficient toxicity data available for risk estimation purposes.

VII.3.5 Uncertainty Assessment

Many uncertainties are associated with the characterization of ecological risks at SWMU 81A. These uncertainties result from assumptions used in calculating risk that could overestimate or underestimate true risk presented at a site. For this risk assessment, assumptions are made that are more likely to overestimate exposures and risk rather than to underestimate them. These conservative assumptions are used in order to favor more protection of the ecological resources potentially affected by contaminants at the site. Conservatisms incorporated into this risk assessment include using maximum measured analyte concentrations in soil to evaluate risk, using wildlife toxicity benchmarks based upon NOAEL values, incorporating strict herbivorous and strict insectivorous diets for predicting the extreme HQ values for the deer mouse, and using 1.0 as the area use factor for wildlife receptors regardless of seasonal use or home range size. Each of these uncertainties, which are consistent among each of the SWMU-specific ecological risk assessments, is discussed in greater detail in the uncertainty section of the ecological risk assessment methodology document for the SNL/NM ER Project (IT July 1998).

Uncertainties associated with the estimation of risk to ecological receptors following exposure to Th-232 and U-235 are primarily related to those inherent in the radionuclide-specific data. Radionuclide-dependent data are measured values that have their associated errors. The dose rate models used for these calculations are based upon conservative estimates on receptor shape, radiation absorption by body tissues, and intake parameters. The goal is to provide a realistic but conservative estimate of a receptor's internal and external exposure to radionuclides in soil.

In estimating ecological risk, background concentrations are included as a component of maximum on-site concentrations. For some inorganic COPECs, conservatisms in the modeling of exposure and risk result in the prediction of risk to ecological receptors when exposed at background concentrations. As shown in Table 18, the HQ associated with exposure of plants to background chromium concentrations is greater than 1.0. Background may account for as much as 91 percent of the HQ chromium at SWMU 81A. It is, therefore, likely that actual risk to plants from exposure to chromium at SWMU 81A is overestimated by the HQs calculated in this screening assessment because of conservatisms incorporated into the exposure assessment and in the toxicity benchmarks for these COPECs.

A significant source of uncertainty associated with the prediction of ecological risks at this site is the use of the maximum measured concentrations or detection limits to evaluate risk. This results in a conservative exposure scenario that does not necessarily reflect actual site conditions. To assess the potential degree of overestimation caused by using the maximum measured soil concentrations in the exposure assessment, the average soil concentration was calculated for chromium (the only COPEC with an HQ greater than unity) to determine whether this HQ can be accounted for by the magnitude of the extreme measurement. The average concentration of total chromium was determined to be 13.4 mg/kg, which is less than the background screening value.

Based upon this uncertainty analysis, ecological risks at SWMU 81A are expected to be very low. An HQ greater than unity was initially predicted; however, closer examination of the exposure assumptions revealed an overestimation of risk primarily attributed to the conservative selection of the exposure concentrations and to the contribution of background risk.

VII.3.6 Risk Interpretation

Ecological risks associated with SWMU 81A were estimated through a screening assessment that incorporated site-specific information when available. Overall, risks to ecological receptors are expected to be very low because predicted risks associated with exposure to COPECs are based upon calculations using maximum detected values. Predicted risk from exposure in plants to chromium was attributed to using maximum detected values. The average chromium concentration at the site was within the range of background. Based upon this final analysis, ecological risks associated with SWMU 81A are expected to be very low.

VII.3.7 Screening Assessment Scientific/Management Decision Point

After potential ecological risks associated with the site have been assessed, a decision is made regarding whether the site should be recommended for NFA or whether additional data should be collected to assess actual ecological risk at the site more thoroughly. With respect to this site, ecological risks are predicted to be low. The scientific/management decision is to recommend this site for NFA.

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APPENDIX 1
EXPOSURE PATHWAY DISCUSSION FOR CHEMICAL AND RADIONUCLIDE CONTAMINATION

Introduction

Sandia National Laboratories/New Mexico (SNL/NM) proposes that a default set of exposure routes and associated default parameter values be developed for each future land use designation being considered for SNL/NM Environmental Restoration (ER) project sites. This default set of exposure scenarios and parameter values would be invoked for risk assessments unless site-specific information suggested other parameter values. Because many SNL/NM solid waste management units (SWMU) have similar types of contamination and physical settings, SNL/NM believes that the risk assessment analyses at these sites can be similar. A default set of exposure scenarios and parameter values will facilitate the risk assessments and subsequent review.

The default exposure routes and parameter values suggested are those that SNL/NM views as resulting in a Reasonable Maximum Exposure (RME) value. Subject to comments and recommendations by the U.S. Environmental Protection Agency (EPA) Region VI and New Mexico Environment Department (NMED), SNL/NM proposes that these default exposure routes and parameter values be used in future risk assessments.

At SNL/NM, all SWMUs exist within the boundaries of the Kirtland Air Force Base (KAFB). Approximately 157 potential waste and release sites have been identified where hazardous, radiological, or mixed materials may have been released to the environment. Evaluation and characterization activities have occurred at all of these sites to varying degrees. Among other documents, the SNL/NM ER draft Environmental Assessment (DOE 1996) presents a summary of the hydrogeology of the sites, the biological resources present and proposed land use scenarios for the SNL/NM SWMUs. At this time, all SNL/NM SWMUs have been tentatively designated for either industrial or recreational future land use. The NMED has also requested that risk calculations be performed based upon a residential land use scenario. All three land use scenarios will be addressed in this document.

The SNL/NM ER project has screened the potential exposure routes and identified default parameter values to be used for calculating potential intake and subsequent Hazard index (HI), excess cancer risk and dose values. The EPA (EPA 1989a) provides a summary of exposure routes that could potentially be of significance at a specific waste site. These potential exposure routes consist of:

- Ingestion of contaminated drinking water
- Ingestion of contaminated soil
- Ingestion of contaminated fish and shell fish
- Ingestion of contaminated fruits and vegetables

- Ingestion of contaminated meat, eggs, and dairy products
- Ingestion of contaminated surface water while swimming
- Dermal contact with chemicals in water
- Dermal contact with chemicals in soil
- Inhalation of airborne compounds (vapor phase or particulate)
- External exposure to penetrating radiation (immersion in contaminated air; immersion in contaminated water and exposure from ground surfaces with photon-emitting radionuclides).

Based upon the location of the SNL/NM SWMUs and the characteristics of the surface and subsurface at the sites, we have evaluated these potential exposure routes for different land use scenarios to determine which should be considered in risk assessment analyses (the last exposure route is pertinent to radionuclides only). At SNL/NM SWMUs, there does not currently occur any consumption of fish, shell fish, fruits, vegetables, meat, eggs, or dairy products that originate on site. Additionally, no potential for swimming in surface water is present due to the high-desert environmental conditions. As documented in the RESRAD computer code manual (ANL 1993), risks resulting from immersion in contaminated air or water are not significant compared to risks from other radiation exposure routes.

For the industrial and recreational land use scenarios, SNL/NM ER has, therefore, excluded the following four potential exposure routes from further risk assessment evaluations at any SNL/NM SWMU:

- Ingestion of contaminated fish and shell fish
- Ingestion of contaminated fruits and vegetables
- Ingestion of contaminated meat, eggs, and dairy products
- Ingestion of contaminated surface water while swimming.

That part of the exposure pathway for radionuclides related to immersion in contaminated air or water is also eliminated.

For the residential land use scenario, we will include ingestion of contaminated fruits and vegetables because of the potential for residential gardening.

Based upon this evaluation, for future risk assessments, the exposure routes that will be considered are shown in Table 1. Dermal contact is included as a potential exposure pathway in all land use scenarios. However, the potential for dermal exposure to inorganics is not considered significant and will not be included. In general, the dermal exposure pathway is generally considered to not be significant relative to water ingestion and soil ingestion pathways but will be considered for organic components. Because of the lack of toxicological parameter values for this pathway, the inclusion of this exposure pathway into risk assessment calculations may not be possible and may be part of the uncertainty analysis for a site where dermal contact is potentially applicable.

Table 1
Exposure Pathways Considered for Various Land Use Scenarios

Industrial	Recreational	Residential
Ingestion of contaminated drinking water	Ingestion of contaminated drinking water	Ingestion of contaminated drinking water
Ingestion of contaminated soil	Ingestion of contaminated soil	Ingestion of contaminated soil
Inhalation of airborne compounds (vapor phase or particulate)	Inhalation of airborne compounds (vapor phase or particulate)	Inhalation of airborne compounds (vapor phase or particulate)
Dermal contact	Dermal contact	Dermal contact
External exposure to penetrating radiation from ground surfaces	External exposure to penetrating radiation from ground surfaces	Ingestion of fruits and vegetables
		External exposure to penetrating radiation from ground surfaces

Equations and Default Parameter Values for Identified Exposure Routes

In general, SNL/NM expects that ingestion of compounds in drinking water and soil will be the more significant exposure routes for chemicals; external exposure to radiation may also be significant for radionuclides. All of the above routes will, however, be considered for their appropriate land use scenarios. The general equations for calculating potential intakes via these routes are shown below. The equations are from the Risk Assessment Guidance for Superfund (RAGS): Volume 1 (EPA 1989a, 1991). These general equations also apply to calculating potential intakes for radionuclides. A more in-depth discussion of the equations used in performing radiological pathway analyses with the RESRAD code may be found in the RESRAD Manual (ANL 1993). Also shown are the default values SNL/NM ER suggests for use in RME risk assessment calculations for industrial, recreational, and residential scenarios, based upon EPA and other governmental agency guidance. The pathways and values for chemical contaminants are discussed first, followed by those for radionuclide contaminants. RESRAD input parameters that are left as the default values provided with the code are not discussed. Further information relating to these parameters may be found in the RESRAD Manual (ANL 1993).

Generic Equation for Calculation of Risk Parameter Values

The equation used to calculate the risk parameter values (i.e., hazard quotients/hazard index [HI], excess cancer risk, or radiation total effective dose equivalent [dose]) is similar for all exposure pathways and is given by:

Risk (or Dose) = Intake x Toxicity Effect (either carcinogenic, noncarcinogenic, or radiological)

$$= C \times (CR \times EFD/BW/AT) \times \text{Toxicity Effect} \quad (1)$$

where

C = contaminant concentration (site specific)
CR = contact rate for the exposure pathway
EFD = exposure frequency and duration
BW = body weight of average exposure individual
AT = time over which exposure is averaged.

The total risk/dose (either cancer risk or HI) is the sum of the risks/doses for all of the site-specific exposure pathways and contaminants.

The evaluation of the carcinogenic health hazard produces a quantitative estimate for excess cancer risk resulting from the constituents of concern (COC) present at the site. This estimate is evaluated for determination of further action by comparison of the quantitative estimate with the potentially acceptable risk range of 1E-6 for Class A and B carcinogens and 1E-5 for Class C carcinogens. The evaluation of the noncarcinogenic health hazard produces a quantitative estimate (i.e., the HI) for the toxicity resulting from the COCs present at the site. This estimate is evaluated for determination of further action by comparison of this quantitative estimate with the EPA standard HI of unity (1). The evaluation of the health hazard due to radioactive compounds produces a quantitative estimate of doses resulting from the COCs present at the site.

The specific equations used for the individual exposure pathways can be found in RAGS (EPA 1989a) and the RESRAD Manual (ANL 1993). Table 2 shows the default parameter values suggested for used by SNL/NM at SWMUs, based upon the selected land use scenario. References are given at the end of the table indicating the source for the chosen parameter values. The intention of SNL/NM is to use default values that are consistent with regulatory guidance and consistent with the RME approach. Therefore, the values chosen will, in general, provide a conservative estimate of the actual risk parameter. These parameter values are suggested for use for the various exposure pathways based upon the assumption that a particular site has no unusual characteristics that contradict the default assumptions. For sites for which the assumptions are not valid, the parameter values will be modified and documented.

Summary

SNL/NM proposes the described default exposure routes and parameter values for use in risk assessments at sites that have an industrial, recreational or residential future land use scenario. There are no current residential land use designations at SNL/NM ER sites, but this scenario has been requested to be considered by the NMED. For sites designated as industrial or recreational land use, SNL/NM will provide risk parameter values based upon a residential land use scenario to indicate the effects of data uncertainty on risk value calculations or in order to potentially mitigate the need for institutional controls or restrictions on SNL/NM ER sites. The parameter values are based upon EPA guidance and supplemented by information from other government sources. The values are generally consistent with those proposed by Los Alamos National Laboratory, with a few minor variations. If these exposure routes and parameters are acceptable, SNL/NM will use them in risk assessments for all sites where the assumptions are consistent with site-specific conditions. All deviations will be documented.

Table 2
Default Parameter Values for Various Land Use Scenarios

Parameter	Industrial	Recreational	Residential
General Exposure Parameters			
Exposure frequency	8 hr/day for 250 day	4 hr/wk for 52 wk/yr	350 day/yr
Exposure duration (yr)	25[a,b]	30[a,b]	30[a,b]
Body weight (kg)	70[a,b]	70 adult[a,b] 15 child	70 adult[a,b] 15 child
Averaging Time (days) for carcinogenic compounds (= 70 y x 365 day/yr) for noncarcinogenic compounds (= ED x 365 day/yr)	25,550[a] 9,125	25,550[a] 10,950	25,550[a] 10,950
Soil Ingestion Pathway			
Ingestion rate	100 mg/day[c]	200 mg/day child 100 mg/day adult	200 mg/day child 100 mg/day adult
Inhalation Pathway			
Inhalation rate (m^3/yr)	5,000[a,b]	260[d]	7,000[a,b,d]
Volatilization factor (m^3/kg)	chemical specific	chemical specific	chemical specific
Particulate emission factor (m^3/kg)	1.32E9[a]	1.32E9[a]	1.32E9[a]
Water Ingestion Pathway			
Ingestion rate (liter/day)	2[a,b]	2[a,b]	2[a,b]
Food Ingestion Pathway			
Ingestion rate (kg/yr)	NA	NA	138[b,d]
Fraction ingested	NA	NA	0.25[b,d]
Dermal Pathway			
Surface area in water (m^2)	2[b,e]	2[b,e]	2[b,e]
Surface area in soil (m^2)	0.53[b,e]	0.53[b,e]	0.53[b,e]
Permeability coefficient	chemical specific	chemical specific	chemical specific

[a]Risk Assessment Guidance for Superfund, Vol. 1, Part B (EPA 1991).
[b]Exposure Factors Handbook (EPA 1989b).
[c]EPA Region VI guidance.
[d]For radionuclides, RESRAD (Argonne National Laboratory, 1993. *Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD*, Version 5.0, ANL/EAD/LD-2, Argonne National Laboratory, Argonne, IL. 1993) is used for human health risk calculations; default parameters are consistent with RESRAD guidance.
[e]Dermal Exposure Assessment (EPA 1992).

ED = Exposure duration.
EPA = U.S. Environmental Protection Agency.
hr = Hour.
kg = Kilogram(s).
m = Meter(s).
mg = Milligram(s).
NA = Not available.
wk = Week.
yr = Year.

References

ANL, see Argonne National Laboratory.

Argonne National Laboratory (ANL), 1993. *Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD*, Version 5.0, ANL/EAD/LD-2, Argonne National Laboratory, Argonne, IL.

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ADDITIONAL /SUPPORTING DATA

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